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MECHANICAL ENGINEERING

INCLUDING THE ENGINEERING INDEX

IN THIS NUMBER

Power-Plant Evolution
By C. F. Hirshfeld

Elimination of Waste in Industry—
Report of A.E.C. Committee

Automatic Die-Sinking Machines
By J. F. Keller

Four Papers Presented at the Providence
Meeting of the A.S.M.E. Textile Division

Water Treatment for Boilers
By J. S. Simsohn

Efficiency in Oil-Burning Steam Plants
By C. H. Delany

SEPTEMBER · 1921

THE MONTHLY JOURNAL PUBLISHED BY THE
AMERICAN SOCIETY OF MECHANICAL ENGINEERS

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Volume 43 | September, 1921 | Number 9

TABLE OF CONTENTS

Power-Plant Evolution, C. F. Hirshfeld 575
Report on Elimination of Waste in Industry 579
Die Sinking and Metal Patternmaking by Automatic Machine, J. F. Keller 584
Variable-Speed Motors in Finishing Plants, W. B. Lewis 589
The Microscopy of Textiles, F. J. Hoxie 592
Winding as Related to the Textile Industry, G. W. Foster 594
Utilization of Low-Grade Cotton and Staple Waste, E. H. Rooney 596
Water Treatment for Boilers, J. S. Simsohn 597
The Absorption of Gasoline from Casinghead Gas by Activated Charcoal, H. R. Auerswald 601
Efficient Operation of Oil-Burning Steam Plants, C. H. Delany 603
Survey of Engineering Progress 607
Steam Turbines for Maximum Loads—Short Abstracts of the Month.
Engineering Research 615
Work of the A.S.M.E. Boiler Code Committee 619
Correspondence 619
Progress Report on Symbols in Heat Engineering 623
Editorials 624
What the Virginia Capes Aircraft Bombing Tests Show—The Value of the Waste Report.
News of The Federated American Engineering Societies 627
Engineering and Industrial Standardization 627
Library Notes and Book Reviews 629
Engineering Index 631
A.S.M.E. Affairs (Section Two) 101–112
Advertising Section:
Display Advertisements 641–EI
Consulting Engineers 88
Classified Advertisements 95
Classified List of Mechanical Equipment 96
Alphabetical List of Advertisers 114

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Contributors and Contributions

Power-Plant Evolution

On March 1, 1921, before the Cleveland Section of The American Society of Mechanical Engineers, C. F. Hirshfeld presented an address in which he showed the recent tremendous increase in electrical power development and forecasted the possible solution of problems of greater economy in power-plant work. Mr. Hirshfeld was graduated from the University of California and took graduate work at Cornell University where he became instructor first in experimental engineering, and later in power engineering. He left Cornell in 1914 to take charge of the research department of the Detroit Edison Company, which position he now holds. During the war he was commissioned lieutenant-colonel of the Ordnance Department.

Industrial Waste

For seven months the Committee on the Elimination of Waste in Industry, authorized by the American Engineering Council, has been accumulating and classifying information regarding waste in American industry. This information has been collated in a detailed report, and the abstract appearing in this issue is published in the hope that all management engineers and executives who see it will wish to procure the complete document, and after careful study will scrutinize every angle of the industries in which they are engaged, so that the work of this committee will be fruitful in stimulating action toward the elimination of waste in the industrial organizations of America.

Die-Sinking Machines

At the 1920 Annual Meeting of The American Society of Mechanical Engineers, Joseph F. Keller presented a paper describing various types of automatic and engraving and die-sinking machines, which paper appears in abstract in this issue. Mr. Keller is at present general manager of the Keller Mechanical Engraving Company, a firm with which he has spent his entire engineering career. The development of die-sinking machines has been the by-product of this company, which was originally engaged in the manufacture of dies and of engraving machinery, at which time Mr. Keller served it as works manager and designer.

Textile Papers

The first meeting of the Textile Division of The American Society of Mechanical Engineers was held at Providence on April 12, 1921. The four papers presented at that meeting are abstracted in this issue of MECHANICAL ENGINEERING.

Frederick J. Hoxie, the author of the paper entitled The Microscopy of Textiles, was graduated from the Massachusetts Institute of Technology in 1892, and was for a number of years engaged in the design and installation of bleaching equipment and electric apparatus. He is now engineer and special inspector for the Associated Factory Mutual Insurance Companies, Boston, Mass.

Warren B. Lewis, author of the paper on The Effect of the Variable-Speed Motor on Heat Balance in Finishing Plants, had several years' experience in experimental work with various electric companies. For the past twenty-three years he has been practicing in Providence as a consulting engineer on industrial plant design and construction.

George W. Foster, who presented the paper dealing with Winding as Related to the Textile Industry, has specialized on winding and winding machinery for the past twenty-five years. During the last three years his time with the Universal Winding Company of Providence has been entirely devoted to research work in connection with development in the art of winding.

Elwin H. Rooney, who presented the paper on Utilization of Low-Grade Cotton, is treasurer of the Gordon-Hay Company, Inc., Providence, R. I., and Utica, N. Y. For sixteen years he was associated with the Whitin Machine Works, leaving them in 1916 to become superintendent of the Paramount Knitting Co., of Chicago. He has been with the Gordon-Hay Co. since May 1918.

Boiler-Water Treatment

The problem of water treatment for boilers is of increasing importance with the present trend toward higher pressures and temperatures in steam generation. This topic was treated at the meeting of the A.S.M.E. Philadelphia Section on January 25, 1921, by Julian S. Simsohn. For many years Mr. Simsohn has devoted his efforts particularly to boiler waters and the chemical reactions taking place in boilers. He is consulting water expert for several large firms and is acting head of the organization of Julian S. Simsohn, chemical engineers, Philadelphia, which handles the technical operation of power plants, embracing the chemical engineering of the boiler room as included under water purification, fuel analysis and combustion.

Casinghead Gasoline

The most economical method of securing gasoline from casinghead gas is the object of constant search by engineers in the oil fields. Mr. Howard R. Auerswald, whose paper is abstracted in this issue, made a series of tests on the use of activated charcoal as an absorbent and presented the results of his experiments at the Mid-Continent Section Meeting held at Tulsa, Okla., on April 28-29. Mr. Auerswald was graduated from Carnegie Institute of Technology in 1914. After two years' general shop experience he became associated with the Gypsy Oil Company at Tulsa. He has served as head of the meter department and assistant manager of the gas, water and construction department. He now holds the position of district superintendent.

Oil-Burning Steam Plants

Charles H. Delany, of San Francisco, presented a paper at the joint meeting of the Local Sections of the A.S.M.E. and the A.I.E.E. at San Francisco on March 17, 1921. This paper points out the economies which may be obtained with the burning of oil and discusses prevalent Pacific Coast practice in oil burning. Mr. Delany is now with the Pacific Gas and Electric Company, having been associated with them since 1911. He is a graduate of the Technical University of California and received his M.M.E. from Cornell in 1903. He was engaged in various capacities with the Sterling Boiler Company until 1909, when he was transferred to the Bayonne Works of the Babcock and Wilcox Company as engineer.

MECHANICAL ENGINEERING

Volume 43 September, 1921 Number 9

Power-Plant Evolution

A Discussion of the Decrease Brought About in the Cost of Producing Electric Power, and of the Possibilities of Further Increasing Plant Efficiencies by the Use of Higher Steam Pressures, Air Preheating, Improved Methods of Feedwater Heating, Etc.

By C. F. HIRSHFELD,[1] DETROIT, MICH.

FEW people who are not directly interested realize the tremendous extent to which both modern industrial life and modern family life are dependent on electric energy, or electric power as it is more commonly called. The revolutionary changes in industrial methods which followed the introduction of the water wheel and steam engine have been treated extensively in literature, and almost every one who reads and thinks knows that the entire social structure of today rests, ultimately, on these prime movers. The part played by electric power, however, has not been so widely advertised and is not so well appreciated.

It is practically impossible to obtain accurate and complete data of the electrical power output of the country but it may be stated that the per capita consumption of central-station power has increased from 23 kw-hr. in 1900 to 435 kw-hr. in 1920. These figures represent the growth over a fairly short period and are indicative of the rate at which electrical power has come into use in the country as a whole. As a matter of fact, however, they do not tell the whole story, because much of the electric power used by street railways is not included and because the total population of the country has been used as the divisor. Since the greatest use of power is in the large and small industrial centers, division by the total population of the country gives too small a figure.

To indicate the significance of this feature Fig. 1 is presented. This figure refers to the city of Detroit, which has had a most remarkable growth, and it is therefore not properly representative of all industrial centers, indicating a somewhat extreme case.

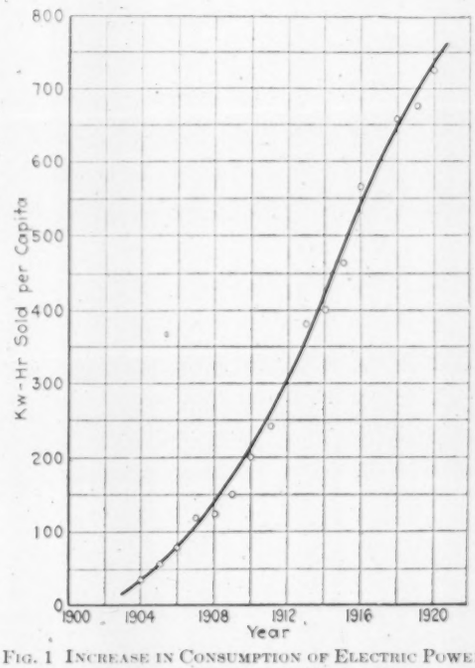

FIG. 1 INCREASE IN CONSUMPTION OF ELECTRIC POWER IN DETROIT BETWEEN 1903 AND 1920

Obviously the production of power by central stations is one of the important items in modern life, and the increasing extent of its use has reacted upon the industry of power generation in a most remarkable way. In the case of fuel-burning stations, to which these observations are confined, the development of more economical apparatus, the improvement of load factor, and the refinement of operating methods have all been such that there has been an almost continuous decrease in the cost of production per unit of output. It should be understood that this decrease results not only from the more economical use of fuel, but also from better use of capital and labor. It is of course common knowledge that the selling price of electrical energy has recently risen in practically all parts of the country. This has been due to abnormal prices of all materials, supplies, and labor, as well as to the attitude of labor toward its work. These things are probably all temporary, and it is expected that their effects will disappear in due time.

Three things have had a predominating influence in bringing about these results, namely—

a Improved load factor

b Increasing size and efficiency of steam turbo-generators, and

c The introduction of efficient mechanical stokers.

It is difficult to give average values for the purpose of showing load-factor improvement because conditions vary greatly from place to place and time to time. However, it will help somewhat to point out that as a central electric supply changes from a pure lighting to a combined lighting and power supply, the load factor changes from something of the order of 10 per cent or less to a value between 50 and 70 per cent. Obviously capital charges per unit of output in the first case are extremely heavy when compared with capital charges in the second case.

The size and efficiency of steam turbo-generators are, of course, readily expressed in numerical form. Fig. 2 is given to illustrate the marvelous developments which have occurred within two decades.

The introduction of efficient mechanical stokers has had two quite different effects. The boiler-room thermal efficiency has been increased to a remarkable degree and the size of units has grown tremendously. In 1900 most central stations were equipped with boilers containing not over 5000 sq. ft. of heating surface. This size has been increased gradually until now units containing between 12,000 and 24,000 sq. ft. are in common use. Paralleling the increase in thermal efficiency and in size, there has been an increase in the efficiency of use of boiler-room labor. It is now possible for one fireman to take complete charge of 5000 rated boiler horsepower.

LIMIT OF DEVELOPMENT ALONG OLD LINES PRACTICALLY REACHED

At the present time we seem to have reached very close to the limit of ultimate development along the lines which have been followed during the past two decades. This statement, however, is not meant to imply that there is no further room for improvement in central stations as they now exist. Obviously, no central station not built within the past year or two can contain all the latest developments. Almost all central-station companies operate one or more old plants which could be improved by reconstruction. In many cases this reconstruction can be economically justified and is being carried on or is contemplated. Nor does it mean that we are unable to build more efficient plants than those just completed.

The real significance of the statement is this: Since about 1900 we have pursued a fairly consistent sort of development along fairly definite lines. During the entire period further possible improvements were always visible and one could predict with a reasonable degree of certainty that each succeeding year would produce certain definite modifications and advances. Now we seem to have reached a point where marked increase of economy in the use of money, labor or fuel can be made only by radical changes of some sort.

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[1] Chief, Research Department, The Detroit Edison Company. Mem. Am. Soc.M.E.

Presented at a meeting of the Cleveland Section of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, MARCH 1, 1921. Slightly abridged.

Rather curiously we arrived at this point in the evolution of the art at just the time when there was the greatest need of conservation in the use of capital, fuel and labor. The driving force furnished by the excessively high prices for money, fuel and labor which have characterized the last two or three years would have been sufficient to cause improvements of tremendous magnitude had we known just what direction to take. Unfortunately we found ourselves at a sort of parting of the ways, and the best brains in the industry in this country and in Europe have been, and are, trying to map the road to be followed in the immediate future.

Out of the work already done have come several very definite indications, but the author cannot feel that any of them promise enough to justify us in concluding that they mark the way. Rather are they to be considered merely as the finishing touches to the

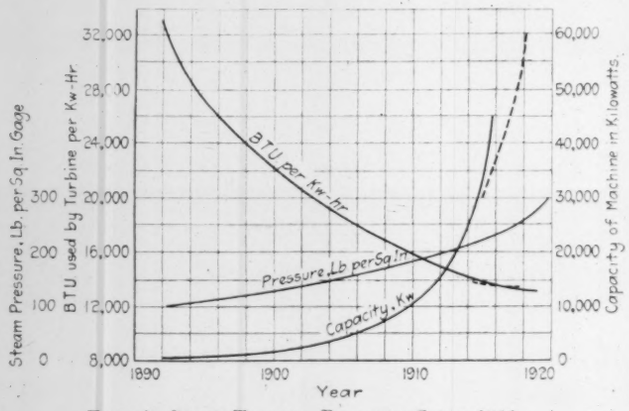

FIG. 2 STEAM-TURBINE PROGRESS SINCE 1892
(Dotted lines refer to compound machines)

existing type. It is his belief that we are just polishing off the steam-turbo-generator type, and that while we may be forced to continue doing so for quite a few years, we are essentially marking time while waiting for a new, epoch-making design, invention or development.

There is nothing now in sight which promises any change so revolutionary as the introduction of the steam turbine or the stoker, but this must not be interpreted to mean that the author does not believe something of this sort is coming. He feels perfectly certain that development will be even more rapid in the future than it has in the past and that, as a result, the allowance for obsolescence should be made higher in the future rather than lower. With the foregoing paragraphs to serve as an introduction we may now enumerate and possibly evaluate the changes now occurring and those which are apt to occur in the near future.

All engineers who are familiar with the theory of steam engines and other heat engines know that theory indicates increasing thermal efficiency as upper and lower temperatures of the working substance are moved farther apart. In the case of the steam turbine this is equivalent to saying that the thermal efficiency will improve as the temperature of the steam reaching the unit is raised and as the back pressure, and therefore the temperature of steam leaving the unit is decreased.

We already have many stations operating with maximum steam temperatures of 600 deg. fahr. or higher and we are rapidly approaching a temperature of 700 deg. A value between 700 and 800 is generally considered to be the highest that should be used with the metals and alloys and the types of construction now available. In the opinion of the author 700 deg. fahr. is about as high as we can safely go at present.

At the other end of the temperature scale, we are now operating our best plants with an average back pressure throughout the year of about one inch of mercury, and there does not seem to be any possibility of greatly improving this performance.

ECONOMIC POSSIBILITIES IN USE OF HIGHER STEAM PRESSURES

With the temperature limits thus definitely set and already practically attained, engineers have begun to consider seriously the possibilities of using higher steam pressures without exceeding the upper temperature limit. It is commonly known that the temperature of saturated steam increases with pressure, but the form of the curve connecting pressure and temperature is not generally appreciated. Such a curve is given in Fig. 3. It is obvious that temperature increases very rapidly with respect to pressure at low pressures, but that this relation is reversed at high pressures. At present a few central stations are using, or are being constructed to use, a pressure of from 300 to 350 lb. per sq. in. The curve of Fig. 3 shows that saturated steam at such pressures has a temperature well below 450 deg. fahr. If we assume it will be possible to utilize pressures as high as, say, 500 lb. per sq. in. in the near future, we will reach a saturation temperature only a little higher than 450 deg. fahr. To attain steam with a saturation temperature of only 600 deg. we should have to utilize a pressure of almost 1600 lb.

It is quite obvious that if we are to operate with the highest permissible temperature we must use superheated steam, even if we increase the maximum pressure to the highest imaginable limit. The curves of Fig. 4 are presented to indicate the theoretical possibilities of higher pressures.

It will be observed that the theoretical efficiency of the cycle increases with increasing pressure for both saturated and superheated steam. It will also be observed that at the temperatures to which we seem to be restricted the gain resulting from increasing the pressure from 200 lb. per sq. in. to 300 lb. is greater than for the next 100-lb. increase, and so on up to the highest pressures shown. Moreover, the maximum efficiency shown is not so much higher than the indicated for pressures and temperatures now in use that radical increase of pressure and temperature holds great promise.

A modern plant with steam pressure between 200 and 225 lb. and with a steam temperature of about 600 to 650 deg. fahr. can produce power at a cost of about 19,000 B.t.u. in fuel per net kilowatt-hour. If the same ratio between actual results and theoretical efficiency of cycle holds for higher pressures and temperatures, we should be able to produce a kilowatt-hour for about 17,500 B.t.u. with steam at 400 lb. and 700 deg. fahr. Taking probable extreme limits and assuming 600 lb. and 800 deg. fahr., the cost of a kilowatt-hour would be about 16,000 B.t.u.

Such figures are certainly worth striving for, but unfortunately

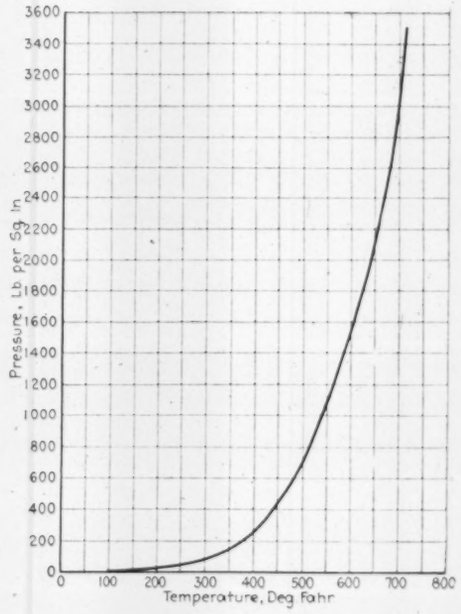

FIG. 3 VARIATION OF TEMPERATURE OF SATURATED STEAM WITH PRESSURE

they do not tell the whole story. First, the cost of equipment will certainly increase with pressure and, to a certain extent, with temperature. Increased thermal efficiency will therefore certainly be partly offset by increased capital charges. Second, the ratio of actual to theoretical turbine efficiency should decrease with increasing pressure, so that the thermal gain to be derived from high pressures must be discounted to a certain extent. Third, the increased boiler pressure means increased flue-gas temperatures

and this must result in offsetting part of the calculated improvement. If this increased loss is prevented by the installation of a device like an economizer of air preheater, we have increased capital and operating charges to consider.

It is the author's opinion that it will be quite a while before we resort to pressures higher than 400 lb. and that fuel will have to cost much more than is probable for the immediate future, while capital must, if anything, cost less to justify exceeding such a value. Against this is to be set the fact that we are now using or preparing to use 350 lb. in this country and that in England they have already exceeded 400 lb.

FERRANTI'S PROPOSED TURBINE CYCLE—THE EMMET MERCURY BOILER

Many years ago S. Z. Ferranti suggested an interesting modification of the turbine cycle. He proposed to add heat during the early part of the expansion so as to maintain the steam at a constant temperature during that part of the cycle. Practical difficulties led to a modification which has to most people obscured the original suggestion. In the modified form the steam is permitted to expand in the same way as it is now customary, but is completely withdrawn from the turbine at different points, reheated, and returned to continue the expansion. In theory this cycle promises an improvement of about 10 per cent over the cycle now in use. If actually used in an operating plant it is probable that not over 5 to 6 per cent improvement could be shown. Against this would be chargeable increased capital costs and increased operating complications.

It is rumored that this cycle in a simplified form is to be used in a new English plant now under construction. It has actually been used in experimental apparatus, and according to reports the results were satisfactory.

Another interesting suggestion emanates from W. L. R. Emmet. Many binary cycles have been proposed and thermal savings can be calculated for most of them, but the one suggested by Emmet seems to be the most promising. He proposes the use of mercury as one working substance and water as the other. The mercury is vaporized in a fuel-fired boiler something like a steam boiler, is expanded in a small turbine and condensed in a device which may be called a condenser-boiler. This device transmits the latent heat of vaporization of the mercury vapor to the water, converting it into steam which is used in a turbine in the ordinary way. Mercury boils at 677 deg. fahr. under atmospheric pressure and at 457 deg. under a pressure of 2 in. of mercury. It thus is ideally fitted to extend the upper temperature limit without introducing prohibitive pressures. It also has such other physical characteristics that a comparatively cheap turbine can be used.

This proposal of Mr. Emmet's is by all odds the most promising of the binary types and it seems to be the only one that warrants serious consideration at the present time. It promises a return of about 40 per cent more power from a given quantity of fuel, and this without a prohibitive increase in investment.

RESULTS EFFECTED BY EMPLOYMENT OF MECHANICAL STOKERS

Turning now from a consideration of the turbine room to the boiler room, the introduction of the efficient and flexible mechanical stoker has reacted in two different ways. It has made it possible to obtain much higher boiler-room efficiency day in and day out, month after month, and it has made it possible to drive boilers at much higher ratings than were even dreamed of a comparatively short time ago. Increasing the quantity of steam which can be produced from a given equipment naturally reduces the overhead charges per unit of steam output.

Now the power producer does not care whether his power becomes cheaper because of more efficient use of fuel or because of more efficient use of capital. Consequently there is evident an increasing tendency to overstoker boilers and to drive them at high average rates. This is quite proper if it is not carried too far. Unfortunately the thermal efficiency of boiler units decreases with increasing output above a certain point, and if the rate of evaporation is carried far enough a point is reached at which decreased thermal efficiency and increased maintenance more than balance the savings in capital. The point at which this occurs differs with the character of equipment, the price of capital, the price of coal, the load factor and other considerations, but under average central-station conditions the most economical point will generally be found below 200 per cent of normal rating if economizers are not used. The addition of economizers naturally raises the proper value. It is probable that the cost of capital and apparatus will ultimately come down to prewar figures or very nearly to such figures, and it is equally probable that the cost of fuel will not. Under such circumstances the economic balance will probably be found to occur at a lower average rate of evaporation than some designers have expected.

ECONOMIZER PROBLEMS

One of the principal losses occurring with high boiler ratings results from high flue-gas temperature. This loss can be partly recovered by the use of economizers. However, economizers cost money to install, money to maintain and money to operate, and the waste is not therefore entirely recoverable. Some designers of power plants appear to give inadequate weight to some of the costs incurred in the practical operation of economizers.

It is rather interesting to note in passing that despite the increase in the price of coal during the past six years, the situation with respect to the installation of economizers has not materially

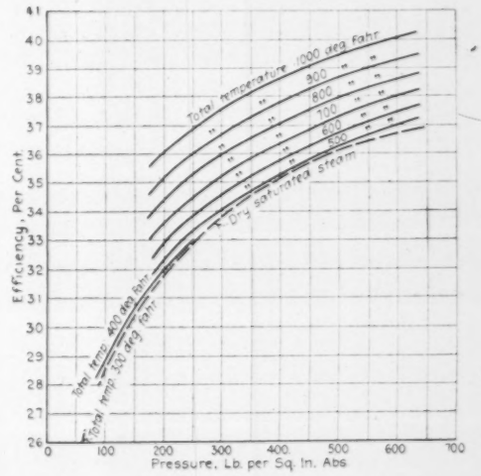

FIG. 4 EFFICIENCY OF COMPLETE EXPANSION CYCLE AS USED IN STEAM TURBINES (BACK PRESSURE, 1 IN. HG.)

changed. The author knows of cases in which quotations on economizers increased during the same period at such a rapid rate that despite the increasing cost of coal the installation of economizers could not be justified. This is probably a transient situation; the cost of economizers may be expected to drop to a point which will place them in a much more advantageous position than that occupied before the war.

But here we are faced with another complication. Economizers until quite recently were made of cast iron exclusively. As the steam pressure in use has risen more and more, engineers have begun to question the propriety of using cast iron for such apparatus. It seems certain that all will agree that if we adopt pressures like those we are now considering, cast iron will be ruled out unless we operate economizers at a pressure much below the boiler pressure. This introduces undesirable complications.

Such considerations have led to the construction and use of wrought-steel economizers. These can be built with factors of safety equal to those used in boiler construction; they are practically as satisfactory as cast iron with respect to corrosion on the gas side, but are much more apt to corrode on the water side. In fact, it is possible to cause failure of steel economizer tubes by corrosion on the water side within a year.

In modern plants such corrosion is generally due to dissolved oxygen and can be prevented if proper precautions are taken to keep the boiler feed sufficiently free of this gas. There are now several well-recognized methods of doing this.

AIR PREHEATERS

Within the past few years another device has been introduced for conserving heat otherwise lost in flue gases. This is the air preheater. Air used for combustion must be heated to furnace temperature from the temperature with which it enters the furnace. Ordinarily this is done in the furnace at the expense of heat liberated by the fuel. That part of this heat which is required to raise the temperature to a value equal to that with which the flue gases leave the boiler is wasted through the boiler damper.

If a large fraction of this heat could be conserved by transferring it from flue gases to entering air by means of an air preheater, a fuel saving of 10 per cent or more could be made. It does not seem probable that any such complete transfer can be effected in a real case, but some fraction of it is certainly attainable. It appears as though a saving of 3 to 5 per cent might prove possible.

However, this device also introduces problems of its own. It can be built comparatively cheaply, but its use involves additional flues and fans and power for driving the fans, so that the gross thermal gain in any case will be partly offset by increased thermal expenditure and increased capital charges. Further, it seems certain that air preheaters will present new cleaning and maintenance problems which will also yield items of expense which must be balanced against the gross thermal saving.

In addition to all these considerations we have another which may prove of still greater importance. We do not yet know the limiting temperature to which it is permissible to raise the air. The air supplied for burning fuel on the grate or stoker passes through that device and serves to cool it by removing heat which is radiated and conducted to it. It is certain that we can use air temperatures higher than those now common, but whether we will find 150 deg. fahr. or 300 deg. or 500 deg. to be the upper limit, is still unknown. The author is inclined to think that the upper limit will vary with the type of stoker and it is obvious that it will vary with the rate of combustion.

FEEDWATER HEATING

Great improvements have been made in the character of boiler feedwater used in the large plants of the country in the past decade. In the early days we used for boiler feed or make-up water anything which was readily attainable. If the scale deposited in the boiler was of such character as to cause too much trouble, we treated the water chemically before use. But we still concentrated a chemical solution in our boilers, had to blow down at frequent intervals and were forced to shut down and thoroughly clean them out periodically.

We have now greatly improved this practice in the case of plants using surface condensers. In such plants the greater bulk of the water evaporated in the boiler is used over and over, being contained in what one might call a practically closed circuit. There is a certain loss from leakage, blowdown, spillage, etc., but this can be kept down to a value between 1 and 2 per cent of the total boiler feed by careful management. The make-up required to make good this loss is now commonly distilled and enters the system as a vapor, leaving dissolved salts behind in the evaporator.

With a plant operated in this way there is practically no deposit in the boiler. As a result blowdown losses are practically eliminated. Of still greater importance, however, is the fact that the expense of shutting down, opening up the boiler and turbining the tubes is almost completely done away with. In this case the improvement results not so much in a thermal gain as in decreased labor and maintenance charges and better use of invested capital.

Much thought has also been given recently to different methods of obtaining auxiliary power and to different methods of heating the feedwater. These factors are closely tied to the use of economizers and air preheaters, and that method which is best under one set of conditions is not necessarily usable with a different type of plant.

We seem to be settling down to two different types, although the whole subject is as yet admittedly in a state of flux. In the one type steam-driven house generators are used to supply some or all of the auxiliary power. The steam exhausted heats the feedwater in heater-condensers operating at such a vacuum as to give a feedwater temperature sufficiently low for advantageous use in economizers. In the other type the feedwater is heated by steam withdrawn from the main unit. This heating is preferably done in stages, and if the idea is carried to the limit, it results in the introduction of a cycle which is theoretically more efficient than the simple, so-called Rankine cycle now in use. Unfortunately, if this arrangement is carried to the ultimate limit it yields feedwater with a temperature higher than can be used advantageously in economizers. It also has another disadvantage from the view point of the central station. Auxiliary power must logically be taken from the main bus and continuity of service is correspondingly jeopardized.

UTILIZATION OF LOW-GRADE FUELS

No consideration of the evolution of power plants would be complete without a reference to the work which is being done in an effort to make available for use the poorer grades of fuel. Stokers are continuously under development and we are already obtaining very promising results with fuels which only a few years ago were practically unusable. Further, many attempts are being made to introduce pulverized fuel into central-station boiler rooms, and one large new plant is being completely equipped for the use of such material. Much is promised by the pulverized-fuel advocates in the way of increased thermal efficiency, decreased labor charges, and ability to use poorer grades of coal. As yet the case is not proved, but the experience of the next five years should bring out the facts. Personally, the author believes that the preparation of the fuel for the burner must be greatly simplified and cheapened before pulverized coal can compete with good stokers under central-station conditions in most sections of the country, but it must be confessed that many engineers in the industry do not share in this view.

So much for the trend of the times in power-plant design. It will now be of interest to attempt to evaluate all the possible improvements in sight.

FUTURE POSSIBILITIES IN PLANT EFFICIENCIES

If we assume that we will continue to use steam turbines and other equipment of the present types, but that we will increase pressure and temperature to the limit and will introduce all possible heat-saving devices, we can lay down on paper a plant which should deliver a net kilowatt-hour for between 14,000 and 15,000 thermal units. This would correspond to overall thermal efficiencies of the order of 24 or 23 per cent. Our best plants of the present day give values of 18 to 19 per cent.

The author is certain that with the fuel prices which are to be expected in this country in the immediate future, such thermally efficient plants would not represent the best engineering or economic solution of the problem. The investment would in his opinion be higher than could be justified. On the other hand, he does expect to see a figure between 16,000 and 17,000 attained in the very near future.

In a number of cases of economizer installations made during the last few years it has been found that the fans were of too small capacity to handle the desired overloads. This has apparently been due in large measure to amounts of excess air much beyond what was expected. Some engineers figure 10 to 20 per cent air infiltration in an economizer setting alone, and there is often a large amount passing into the boiler setting, especially in a multiple header boiler. It is also frequently the case that smoke flues are far from tight, especially at riveted and expansion joints. One plant reports the infiltration between a large boiler and cast-iron economizer to be relatively small (about 500 to 2000 cu. ft. of air per minute), but the infiltration through the economizer casing and stack uptake to be greater, ranging from 4000 cu. ft. with air leaks cemented up to 20,000 cu. ft. in an extreme case. Another station, with steel-cased economizers, reports negligible infiltration. The result of high excess air is, of course, to increase the volume of the flue gases and also the draft required. As modern fans have definite draft-volume-speed characteristics, the results are often to throw the fan performance beyond proper limits.—From 1921 Report of the Prime Movers Committee of the National Electric Light Association.

Report on Elimination of Waste in Industry

Committee Authorized by American Engineering Council and Appointed by Herbert Hoover Points Out Wastes and Recommends Steps for Elimination

This report is the first work undertaken by The Federated American Engineering Societies in rendering public service. It discloses losses and waste due to the restraint and dissipation of the creative power of those who work in industry. It lays the foundation for knowledge of the destructive influences which have too much controlled in the past. From this knowledge will grow the conviction that mental and moral forces must be added in a much larger degree to the physical resources now employed if industry is to serve all who are dependent upon its continuous and effective operation.

The Committee believes that this study of waste in industry will prove of lasting benefit to the industries studied and to the public which uses their products. It hopes further that the benefits will be farther reaching, and will extend to other industries by stimulating similar studies and outlining the methods by which they can be made. The Committee believes that such additional studies will prove of great value and that through intelligent application of conclusions reached American industry will take another long stride in advance. In expressing these beliefs the Committee recognizes that many of its findings and recommendations have previously been pointed out by individual engineers, but this report is the first instance of a collective or group endorsement of a general analysis of the sources and causes of waste and recommendations for its elimination.

THE preceding paragraphs appear in the preface of the Report of the Committee on Elimination of Waste in Industry. This Committee was authorized by the American Engineering Council, the executive board of The Federated American Engineering Societies, soon after its organization in the fall of 1920, and on January 12, 1921, Herbert Hoover, as President of the American Engineering Council, appointed its members. At present the Committee consists of the following men: J. Parke Channing, *Chairman*, L. W. Wallace, *Vice-Chairman*, L. P. Alford, George D. Babcock, Wm. R. Basset, F. G. Coburn, Morris L. Cooke, Harrington Emerson, Ira N. Hollis, Herbert Hoover, Edward Eyre Hunt, C. E. Knoeppel, Robert Linton, Fred J. Miller, H. V. R. Scheel, Sanford E. Thompson, John H. Williams, and Robert B. Wolf.

The Committee determined to gather quickly such concrete information as might be used to stimulate action and lay the foundation for other studies. It was believed that a limited, yet carefully studied, volume of findings obtained through a rapid intensive study would not impair the value of the facts disclosed or the validity of the recommendations based thereon, so within five months the Committee completed the assay of waste in six branches of industry and on June 3 presented a summary of its findings to the American Engineering Council. The final report was released for publication on July 15 and printed copies are expected to be issued about the middle of September.

There were three outstanding difficulties in the study of industrial waste: the extent of American industry, the fact that there is no accepted management or labor terminology, and the lack of a method of weighing the performance of industry. The impossibility of making a comprehensive study of the nearly three hundred thousand industrial plants grouped in the census into fourteen major classes is obvious. Neither time nor funds were available for such a task, and even if it might have been attempted, it is doubtful if the results would have been commensurate with the expenditure. Therefore the decision was reached to make a study of a group of representative plants in several industries, whose operation directly affects the daily life of every one. The lack of standardized terminology and of units and methods of measurement was overcome by preparing a standard method of investigation to be used in each branch of industry and in the plants in which intensive studies were made.

The limitations of the study in the industries selected are indicated in the following tabulation:

Branch of Industry	No. of Plants Investigated	No. of Plants Furnishing Additional Information
Building Industry	73	33
Men's Ready-Made Clothing Manufacturing	9	—
Boot and Shoe Manufacturing	8	25
Printing	6	19
Metal Trades	16	17
Textile Manufacturing	13	—

The plan of study followed in each of these six branches of industry was this: At the outset the members of the Committee prepared an analysis of those factors and operations in industry in which waste might be expected to be discovered, provided a comparison was made between average practice and the best known practice. From this analysis a trial questionnaire was prepared to secure information and quantitative data to permit of comparing the record of one plant with another.

This trial questionnaire was then used in making a study of one plant in each industry. The results of these trial studies were then brought together, compared, reviewed by the Committee and, as a result, a revised questionnaire and an evaluation sheet were prepared, to be used in making the studies upon which this report is based.

This revised questionnaire, as used with suggested modifications based on the experience accumulated in its use in the field studies, forms an important part of this report. Wherever it has been used, plant managers have shown marked interest, which has led the Committee to include it in the printed report.

The printed report will be a book of about 130,000 words, divided into three sections: the first, a summary, which will include a statement of the sources and causes of waste with recommendations for waste elimination; the second, the engineers' field reports in the six industries investigated; and the third, general reports on unemployment, strikes and lockouts, legal machinery for adjusting disputes, industrial accidents, health of industrial workers, eye conservation, and purchasing and sales policies, all of which support from a broader point of view many of the specific findings presented in the field reports and for this reason give a more general background for many of the recommendations offered.

Section I, the summary of the report, is presented in abstract below, the omitted material being explanatory or corroborative of the statements printed.

Summary of the Report

IN making the studies upon which this report is based and in preparing the report itself there has been no purpose or desire to place blame upon any individual, group or class. The wastes revealed are the result of methods, tactics, practices and relationships of long standing in industry and the Committee has merely desired to indicate the main opportunities for eliminating waste and to show whose opportunity or responsibility it may be to adopt proper measures for such elimination.

No attempt has been made to write an academic definition of waste or to speculate in regard to ultimate savings. For the purpose of this report no attempt has been made to consider all economic wastes. Rather, in the Committee's investigations *industrial waste has been thought of as that part of the material, time and human effort expended in production represented by the difference between the average attainments on one hand and performance actually attained on the other as revealed by the detailed reports.* In assaying waste in industry the Committee has undertaken to evaluate this difference. Thus it has established no theoretical standard of performance or excellence, but has developed a method of measurement to determine the degree of effective use of those factors within which it was believed waste might be discovered. It has conceived that a given practice is not wasteful until a better has been revealed, and that the value of a newer practice, or the amount by which it is an improvement over an earlier one, can only be determined by units and methods of measurements.

SOURCES AND CAUSES OF WASTE

Waste in industry is attributable to:

1 Low production caused by faulty management of materials, plant, equipment, and men

2 Interrupted production, resulting from idle men, idle materials, idle plants, idle equipment

3 Restricted production intentionally caused by owners, management, or labor

4 Lost production caused by ill health, physical defects and industrial accidents.

Relative Responsibilities. Management[1] has the greatest opportunity and hence responsibility[2] for eliminating waste in industry. The opportunity and responsibility of labor is no less real, though smaller in degree. The opportunity and responsibility chargeable to outside contacts cannot be so clearly differentiated or evaluated. The relative measure of these is shown by the quantities in the following table which come from the composite evaluation sheets in the engineers' field reports:

Industries	Responsibility Assayed Against: Management, Points[3]	Labor, Points	Outside Contacts,[4] Points	Total Points
Men's Clothing Mfg.	48.33	10.50	4.95	63.78
Building Industry	34.30	11.30	7.40	53.00
Printing	36.36	16.25	5.00	57.61
Boot & Shoe Mfg.	30.25	4.85	5.83	40.93
Metal Trades	23.23	2.55	2.88	28.66
Textile Mfg.	24.70	4.70	19.80	49.20

From the preceding table are derived percentage values for each of the agencies against which responsibility is assessed, as follows:

Industry Studied	Responsibility Assayed Against: Management, Per cent	Labor, Per cent	Outside Contacts,[5] Per cent
Men's Clothing Mfg.	75	18	9
Building Industry	65	21	14
Printing	63	28	9
Boot & Shoe Mfg.	73	11	16
Metal Trades	81	9	10
Textile Mfg.	50	10	40

The quantities presented above justify the following statement: Over 50 per cent of the responsibility for these wastes can be placed at the door of management and less than 25 per cent at the door of labor, while the amount chargeable to outside contacts is least of all.[5]

In every industry studied there are outstanding examples of good management, but the bulk of the industry does not approximate this standard. In the clothing industry, for instance, one plant was rated by the engineers 57 points higher than the worst one studied and 42 points better than the average.

The following table gives a comparison, for each industry studied, of the total number of points assessed as waste in the best plant investigated, compared with the average of all the plants:

Industries	Points Assayed Against: Best Plant Studied, Points	Average of All Plants Studied, Points	Ratio of Best to Average
Men's Clothing Mfg.	26.73	63.78	1 : 2
Building Industry	30.15	53.00	1 : 1½
Printing	30.50	57.61	1 : 2
Boot & Shoe Mfg.	12.50	40.83	1 : 3
Metal Trades	6.00	28.66	1 : 4½
Textile Mfg.	28.00	49.20	1 : 1½

These tables present the consensus of opinion of the engineers engaged in field studies to the effect that the average of management is much below the standards set by certain individual executives who have achieved notable success.

It must not be assumed, however, that these points or ratios are valid in comparing the waste in one industry with that in another. They are useful only in making a comparison of waste in plants within the industry where they were assessed. Further, the quantities disclosed by the evaluation sheets are only a part of the findings dealt with in this report.

[1] The term "management" as used in this part of the report refers to the agency (owners or managers) which exercises the management function in industry. This function is defined in a report approved by the Management Division of The American Society of Mechanical Engineers as:

"Management is the art and science of preparing, organizing and directing human effort applied to control the forces and to utilize the materials of nature for the benefit of man."

[2] The "responsibility" of a given agency as here used does not mean moral responsibility as ordinarily understood, but only that responsibility which arises from the undeniable fact that a given cause of waste can be removed only by a particular agency. "We measure responsibility not by the thing done, but by the opportunities which people have had of knowing better or worse."

[3] The relative responsibilities have been evaluated in "points." A theoretical total of 100 points represents all possible waste. As no plant is or could be entirely wasteful, the number of points assigned in any case must be less than 100.

[4] The public, trade relationships, and other factors.

[5] Adjusted by field engineer to a basis comparable with the other field evaluations.

Waste Due to Low Production

Faulty Material Control. In certain industries the waste of materials is a serious drain on production, a fact which is revealed by a comparative study of plants in the same field. The methods of control which are common in the shoe industry account for the greatest loss in shoe production, with the possible exception of seasonal demand and production. The loss from idleness in shoemaking occasioned chiefly by waiting for work and material amounts to some 35 per cent of the time. The average building contractor has no calendar of operations except the dates of starting and finishing a job. He largely regulates deliveries on materials by visits to the job, or through statements received from the job superintendent. Still another waste from inadequate material control comes from the speculative purchasing of raw materials.

Faulty Design Control. The defective control of design results in a major waste, since it prevents standardization of product. Standardization of the thickness of certain walls might mean a saving of some $600 in the cost of the average house. Standardized mill work, such as window frames, doors and other similar items, would reduce the cost. In the printing trades there is wide variation in flat-bed cylinder presses; there are more than six hundred types of folding machines. Formerly each type foundry cast its type on a more or less different body, and although the change from the old system to the point system involved an expenditure of some $3,000,000 by the type founders, it is universally conceded that this expenditure has been saved many times over. Such examples point the way to further efforts.

Another source of waste through inadequate design control comes through defective drawings, specifications and tolerances.

Faulty Production Control. The lack of adequate methods of production control is evident in every industry studied. It is one of the outstanding weaknesses.

In the men's clothing industry it is found that at least ten hours per week per man is thrown away on energy-wasting and time-wasting work resulting from lack of shop methods, while an additional two or three hours per man per week is wasted in unnecessary work. Fixing the value of annual output in the men's ready-made clothing industry at $600,000,000, it should be relatively easy to save three-quarters of a million dollars a day, an increase of 40 per cent in effectiveness.

The lack of production control is not a question of large versus small plants. In the metal trades, for example, the engineer declares that the size of the plant does not necessarily determine its efficiency, for some of the large plants as well as some small ones show a large waste factor.

Lack of Cost Control. The majority of the industrial plants studied lack a knowledge of costs and have no cost control. Therefore there is no adequate method of judging fairly and accurately when improvements are needed and when waste is occurring. Not having the facts prevents prompt correction of defects. The above conditions are disclosed, for example, in the report on the metal trades.

Lack of Research. While certain industries are ahead of the rest in plant research, the need for more intensive research activity is apparent in every industry. One industry which is backward in this respect is clothing. In the majority of men's clothing plants nothing approximating research is practiced to improve materials, processes, equipment or product. The assertion probably will not be challenged that there is not a single individual throughout the entire industry who is solely engaged in research, and is thus without operating duties.

In the shoe industry there is lack of information as to market demands in this country and abroad. In all the leather industries there is need for scientific research to aid in predicting the kinds and quantities of leather required.

Faulty Labor Control. With perhaps two or three exceptions, shoe shops have no departments maintaining modern personnel relations with the employees. In the shoe industry the cost of training an inexperienced man for cutting upper leather in a well-managed shop is $576; for a semi-experienced man, $450; and to

install an experienced man in a different shop costs $50. For the average shop these figures are unquestionably low.

The average labor turnover for the year 1920 in the metal-trades plants covered (wherever records were kept, which was the case in less than half of the plants), was 160 per cent—figured in most cases as the ratio between the number of "separations" and the average number of employees on the payroll. The highest turnover was 366 per cent.

The building trades have given little consideration to the subject of labor turnover. In construction work it is particularly difficult to estimate the extent, because the actual percentage of turnover constantly varies as the building progresses and the number of men is increased and later decreased. Employment managers are rarely employed even upon the largest jobs, and "hiring and firing" is at the will of the foreman or superintendent.

Another fault in labor control is improper or inadequate rate-setting. In negotiations and controversies between employer and operator in the shoe industry, what stands out is the lack of knowledge of facts which can be used as a basis for setting rates.

Ineffective Workmanship. Still another loss resulting in low production arises from inefficient workmanship. For much of this management is responsible through failure to provide opportunities for education or special training. Management cannot, however, do more than provide these facilities, and experience has shown that it is difficult to interest workmen in training courses which are designed to increase effectiveness. Further, much ineffective workmanship arises from lack of interest in work or lack of pride in good workmanship. The field reports give no evaluation of spoilage, which is one of the measures of this form of waste.

Faulty Sales Policies. The cancellation of orders is a condition peculiar to certain industries. It is especially acute in the clothing industry. Purchasers buying on long-time contracts return unsold goods at the end of the season, and claim and receive credit. The evil is general in the clothing and allied industries. It is common practice for manufacturers to oversell the dealers and oversell their own manufacturing capacity. They make and deliver what they can, and cancel the rest of their orders. The manufacturers follow the same bad custom in dealing with the textile mills.

The committee realizes that before there can be a material reduction in the sum total of waste in industry, much earnest, painstaking work must be done. The solution of such a problem is not one of hours or days but of years. Fundamental changes in our economic, financial, managerial and operating concepts and practices will be required. There will be need of both cooperative and individual effort. As regards groups, each must frankly face its own responsibility and meet its own duties. Each individual—plant executive or worker—must discover his own opportunities and then accept responsibility for performance. To such a one, the Committee on the Elimination of Waste in Industry suggests that the methods developed for investigating and compiling the information as revealed in this report be utilized in individual plants to show the way for betterment and improvement.—WASTE REPORT.

Waste Due to Interrupted Production

Idle Men. The amount of idleness or unemployment in industry can only be evaluated through rough estimates. There is no national machinery for collecting the facts. In the best years, however, even the phenomenal years of 1917 and 1918 at the climax of war-time industrial activities, when plants were working to capacity and when unemployment reached its lowest point in 20 years, there was a margin of unemployment amounting to more than a million men. This margin is fairly permanent; seemingly one or more wage earners out of every forty are always out of work.

During periods of industrial and business depressions, unemployment reaches its greatest amount. Such depressions appear more or less regularly at 7- or 10-year periods and each brings its increase in unemployment and wastage of the productive capacity of industry.

In January 1921 a nation-wide survey of employment made by the U. S. Employment Service of the Department of Labor showed that there were 6,070,648 workers then employed in industry as compared with 9,402,000 in January of 1920, a decrease of 3,331,352 or approximately 35.5 per cent. This survey covered 35 states and 182 industrial cities and centers and may be considered as fairly reflecting conditions at that time.

In addition to minimum and climacteric unemployment, many essential industries show a high unemployment or idleness once a year or oftener. Practically all industries are in a sense seasonal. To present a few examples: The clothing worker is idle about 31 per cent of the year; the average shoemaker spends only 75 per cent of his time at work; the building-trade workman is employed only about 190 days in the year or approximately 63 per cent of his time; the textile industry seemingly has regular intervals of slack time; during the past 30 years bituminous-coal miners were idle an average of 93 possible working days per year. In the brick, chemical and glass industries the percentage of full time worked was 85, 84 and 87, respectively. In most years the percentage of lost days is much larger.

Intermittent unemployment brings other wastes. One consequence is a concrete but fallacious industrial philosophy that there is only so much work to be done and that the sensible course of action is to retard production to make employment last throughout the year, or to uphold prices.

Another form of unemployment comes from open conflict between management and labor. Here it should be said that in the past, at least, the amount of waste from the general run of strikes and lockouts through loss of wages and curtailment of production has been less than is popularly supposed. That these disturbances do produce unemployment is true, but in the industries studied they do not of themselves appear to constitute a major source of reduced production. The ramifications of such strikes with their attendant and indirect losses the Committee has been unable to trace.

Since most strikes occur in seasonal employments, it can be deduced that output is not necessarily penalized, for it is often possible to make up the losses incurred by strikes through increased production at other times.

More coal was mined in 1910 than in 1911, although the former year witnessed many protracted strikes involving large numbers of employees. The year 1912, with 47 per cent of the entire labor force out on strike and with an average loss per man of 40 days, showed an increased output of coal per man per day and per year, and six days' more employment than in the year 1911, which, it will be remembered, was relatively strikeless.

In addition to the direct loss of time, however, there is a loss incurred through retarded production previous to and immediately following strikes.

Wages and hours have always been the chief cause of strikes. There has been a marked falling off in the relative number of strikes for this cause in recent years as compared with 1898–1905.

Jurisdictional disputes, that is, strikes by the members of one trade against the performance of work which they regard as belonging to their craft by members of some other craft or trade, are relatively unimportant. In the building trades jurisdictional quarrels represent one-quarter of the total number of strikes.

Idle Material. The waste of idle material through deterioration, obsolescence and carrying charges is large, particularly where there are great inventories of both raw material and finished goods. Unbalanced production is another notable cause of idle materials and consequent waste.

Idle Plants and Equipment. Unsound production policies result in wasteful overequipment. Clothing factories are built 45 per cent larger than is necessary; printing establishments are from 50 per cent to 150 per cent overequipped; the shoe industry has a capacity of 1,750,000 pairs of shoes a day, and produces little more than half that number; throughout the metal trades, standardization of products would permit of large reductions in plant equipment.

Standardization of machine sizes would make possible the use of one machine for a greater variety of different jobs.

It has not been possible in this assay to estimate the amount of idle equipment, nor the accompanying waste through maintenance and depreciation charges.

WASTE RESULTING FROM RESTRICTED PRODUCTION

Restrictions By Owners and Management. Some of the evils of restricted production are chargeable to owners and management. In the building trades the contractors, builders and supply dealers have restricted production by maintaining high prices, collusion in bidding, and unfair practices. At times there has been collusions between employers and labor, tending to raise prices unduly. The waste from these causes cannot be measured in this study.

Restrictions by Workers. Restrictions of individual output for which workers are responsible are susceptible of measurement. They are of two kinds. On the one hand, when workers are scarce, the less conscientious workers become independent and slacken speed, whereas when workers are plentiful, they work with greater diligence and care for fear of unemployment. On the other hand, the dread of unemployment is so pronounced that employees engaged in seasonal enterprises frequently restrict production in order to make employment last longer; some workers, moreover, through consideration of their fellow-employees, limit production to provide work for them, a practice which ultimately results in an economic loss.

The tools of the engineer are standard weights and measures, scientifically established. He cannot serve industry unless he can set standards for production and can measure work performed. Many unions now oppose the use of such standards. Practically all of the printing unions oppose these devices. The rules of the craft unions in the building trades also object to many labor-saving devices, and thus contribute to waste in that industry.

The restriction of the number of apprentices is a common rule. The rule requiring that members of one craft union shall not encroach upon the work of another results in large waste and little benefit. Unions frequently require three or four skilled employees to perform various operations on a plain job which a single worker could satisfactorily do by himself. Union carpenters are forbidden to lay bricks, union plumbers are forbidden to do carpentering work, and so forth. Unions are also charged with restricting the use of machinery.

A union rule in newspaper printing requires that all advertising matter coming into the plant in electrotype form must be reset by the compositors. This useless work is sometimes done weeks after the advertisement has appeared.

WASTE CAUSED BY LOST PRODUCTION

Ill Health. In discussing public health conditions there is no clear distinction between the standing of the 42,000,000 persons classed as gainfully employed in the United States and those specifically engaged in industry. The 42,000,000 men and women gainfully employed probably lose on an average more than eight days each annually from illness disabilities, including non-industrial accidents —a total of 350,000,000 days. Of the 500,000 workers who die each year, it is probable that the death of at least one-half is postponable by proper medical supervision, periodic medical examination, health education, and community hygiene.

Assuming that the average life has, aside from all spiritual and human values, an economic value to industry of not less than $5000, and assuming that the special diet, care, and medical attention required by a man chronically ill costs $3 per day, it has been estimated that the economic loss from preventable disease and death is $1,800,000,000 among those classed as gainfully employed, or over $700,000,000 among industrial workers in the more limited meaning of the term.

Defective Vision and Defective Teeth. It is estimated that 25,000,000 workers have defective vision requiring correction. It is the experience of a number of plant executives that the correction of sub-standard vision brings increased quality and quantity of production, sufficient to pay for the cost. A very large proportion of workers have defective teeth and mouth infection, and other serious physical defects which reduce their effectiveness.

Industrial Accidents. In 1919 there occurred in industry about 23,000 fatal accidents, about 575,000 non-fatal accidents causing four weeks or more of disability, and 3,000,000 accidents causing at least one day's disability. The time lost is estimated to be 296,000,000 days, giving an economic loss to the country of about $853,000,000 for the year 1919. This does not include the costs to employers and employees for medical and surgical aid and hospitals' bills, and the overhead expenses of insurance.

RECOMMENDATIONS FOR THE ELIMINATION OF WASTE IN INDUSTRY

In preparing this third part of the summary, the Committee has endeavored to interpret responsibility in terms of what might be done to eliminate waste in industry. The policies and methods recommended are such as are already in successful use in the industries and plants investigated.

RESPONSIBILITY OF MANAGEMENT

Improvement of Organization and Executive Control. Planning and control should be adopted as fundamentals of good management. For the most part they have not as yet penetrated the mass of American industry.

Production Control. Conscious production control tends to reduce or eliminate waste by shortening the total time of production. Material schedules should be installed and used. Work in process should be planned in advance by methods which will insure its timely delivery to the machine or operation where it is needed, so that there will be no idleness between jobs.

Balancing Productive Capacity and Demand. The sound relation between capacity and demand is shown only as a wise policy is adopted in regard to planning, routing, and scheduling work, and as improved shop methods are put into effect.

Development of Purchasing Schedules. There should be the same coördination of the purchasing function and careful control of material purchased and not yet received as is given to material already in the plant.

Elimination of Cancellations and Curtailment of Returns. The practice of cancellation of orders between manufacturer and customer should be eliminated and there should be a curtailment of the privilege of returning goods ordered and received.

Correlation of Production Schedules with Sales Policies. Production schedules should be based on a carefully formulated sales policy determined from an intensive study of markets, thus stabilizing production.

Inspection. The aggregate annual wastage of human effort and goods from spoiled and defective work is appalling. The indirect losses, which are harder to detect and measure, are often greater than the direct losses.

Maintenance of Plant and Equipment. Upkeep of plant is conducive to maximum production, as it assures that equipment and machinery will be continually in a condition to operate.

Uniform Cost Accounting. In controlling production and in judging fairly and accurately when and where progress and improvement are being made, the lack of a good cost-control system is necessarily a source of much waste.

Methods of Wage Payment. Methods of wage payment should be adopted, equitable and just in their basis, and insuring a proper relationship between effort put forth and results achieved by all who participate in the enterprise.

Standardization of Product. Products should be standardized, consistent with progressive development of manufacturing.

Standardization of Materials. Materials should be standardized to the fewest practicable kinds, sizes and grades.

Standardization of Equipment. At least the details of equipment, including machines and tools, should be standardized so as to permit of the widest interchangeability and maximum usefulness consistent with improvements in design and invention.

Performance Standardization. Performance standards should be developed as a valuable aid to planning and production control.

Management and Workers. Management has a definite responsibility in selecting, upgrading and in maintaining personnel. Experience indicates that the best results can be obtained when employment and personnel direction develops a sense of mutual interest in production on the part of management and workers.

Prevention of Accidents. Management has a definite responsibility to prevent industrial accidents. Systematic preventive measures can and should be inaugurated.

Research. The need for knowledge obtained by industrial research was manifest in every industry studied.

RESPONSIBILITY OF LABOR

Increasing Production. The need for facts instead of opinions stands out everywhere in the assay of waste from intentional restrictions of output. No service which workers can render can be socially more valuable than that of studying the needs of the industries in which they earn a livelihood, and allying themselves with the technicians who serve with them to increase production which will inure to the ultimate benefit of all.

Standardization of Work. Labor should coöperate to prepare for and even demand the determination of and use of performance standards.

Changing Rules Regarding Restrictions. Labor should change its rules regarding restriction of output, unreasonable jurisdictional classifications, and wasteful methods of work, thereby removing some sources of waste.

Improving Health and Reducing Accidents. Labor is responsible no less than management for improving the health of the workers and for preventing accidents in industry.

Improving Industrial Relations. Inasmuch as the organization of personnel relationships in industry can only be accomplished through the coöperation of both employer and employee, labor should assist in such work of organization and in maintaining and utilizing the structure developed.

RESPONSIBILITY OF OWNERS

The owners of industry, through the banking function or otherwise, share in the responsibility for eliminating waste in industry. They have the duty particularly of assisting in stabilizing production.

RESPONSIBILITY OF THE PUBLIC

Need of Public Interest. In the study of industrial waste, there can be no setting apart of the public as a separate group. A campaign to increase the productivity of industry cannot be conducted without widespread interest and support.

Style Changes. In certain industries the consuming public is to a degree responsible for seasonal fluctuations because of the eagerness with which it accepts or adopts changes in style.

Distribution of Demand. The public can assist in stabilizing industry by accepting a sensible distribution of demand throughout the year.

Community Coöperation With Industry. Public and semi-public agencies can assist by definitely encouraging and supporting the efforts for elimination of waste. Bodies such as local chambers of commerce and other civic and community associations can bring influence to bear through local conferences with the different branches of industry.

OPPORTUNITY OF TRADE ASSOCIATIONS

Trade associations should be formed in those industries lacking comprehensive organizations. They should promote programs for the standardization of cost-accounting methods, the introduction of standardized material specifications, the establishment of production standards, the standardization of equipment, and the standardization of finished products.

OPPORTUNITY FOR GOVERNMENTAL ASSISTANCE

National Industrial Information Service. A national industrial information service should be established to furnish timely, regular, and complete information on current production, consumption and available stocks of commodities, supplementing the work of private agencies.

A National Statistical Service. A national statistical service should be established and maintained covering employment requirements and conditions throughout the country.

Principles for Adjustment and Settlement of Labor Disputes. A body of principles for the adjustment of labor disputes should be accepted which can be developed with experience.

Public Health Policy. The reports dealing with health, prepared in connection with this study by a group of physicians, declare for an aggressive, continuous, national public health policy.

National Program for Industrial Rehabilitation. The national program for industrial rehabilitation should be encouraged. It should offer opportunities for the education and placement of those having physical and mental defects as well as those handicapped by industrial accidents or by war. Formerly such incapacitated men were treated as if they had no economic value. Many striking examples, however, have led to the conviction that many such men can be so trained as to make them useful workers. Comprehensive efforts for their vocational rehabilitation are being made through the coöperation of Federal, State, industrial and commercial agencies.

Nation-Wide Program of Industrial Standardization. A nation-wide program of industrial standardization should be encouraged by the Government in coöperation with industry. In the standardization of design of product, methods of procedure and number of models, there rests a large opportunity for the reduction of waste.

A special service which the Government can render in this connection is the standardization of its own demands. Several government departments have their own paper specifications, for example, with no relation to each other, or to any standard brand. These departments might well take the first step by standardizing the paper they use on the basis of a selected list of well-known brands.

It is not sufficient, however, to attempt to standardize the product of a given industry, for almost every industry is so dependent upon others that they too must coöperate. The Federal Government could call together the representatives of the trade associations of interdependent industries and in coöperation form committees for this purpose. The opinions or decisions of such committees might from time to time be promulgated as standards of practice.

Revision of Federal Laws. Where Federal laws interfere with the stabilization of industry, they should be revised in the interests of the whole people.

The largest area of waste lies in the periods of slack production and unemployment, due to the ebb and flow of economic tides between booms and slumps. Studies of industries as a whole show that we usually expand our equipment at the periods of maximum demand for products instead of doing our plant expansion during periods of slack consumption. While it cannot be expected that all industry could be so stabilized as to do its capital construction in slack periods, there are some industries which could be led in this direction by coöperation with the Government and coöperation among themselves.

As a striking example, in a seasonal industry such as coal mining, no adequate solution regarding stabilization can be found except through organized coöperation of operators, labor, railroads and large consumers. Under existing laws as to combinations, such coöperation cannot be carried out. Therefore, we believe that federal legislation is necessary permitting such coöperation under competent government authority.

DUTY OF ENGINEERS

The duty of engineers is a part of all the responsibilities previously stated in different recommendations.

Engineers come in contact with and influence every activity in industry, and as a body possess an intimate and peculiar understanding of intricate industrial problems. They are in a position to render disinterested service, and their peculiar responsibility is to give expert judgment wherever engineering training and technical skill are needed to reach a just decision.

This report brings forward certain pressing problems concerning the solution of which engineers should hasten to assist. The assays of waste show first the need of definite and quantitative industrial information on a multitude of points. Science has pushed ahead in some directions; it lags behind in others. The duty of the engineer is preëminently a duty to enlarge the boundaries of knowledge. His lifelong training in quantitative thought, his intimate experience with industrial life, leading to an objective and detached point of view, his strategic position as a party of the third part with reference to many of the conflicting economic groups, and above all his practical emphasis on construction and production, place upon him the duty to make his point of view effective.

It is peculiarly the duty of the engineers to use their influence individually and collectively to eliminate waste in industry.

Die Sinking and Metal Patternmaking by Automatic Machine

By JOSEPH F. KELLER,[1] BROOKLYN, N. Y.

WHILE the term "die" is very comprehensive and elastic and is applied to an endless variety of tools, it is to be understood that the methods discussed in the present paper have to do with such dies as are used for stamping, forging, embossing, pressing, etc.; that is to say, such dies as contain the negative or positive of the product to be formed or decorated.

Among the industries to which such dies or molds are a fundamental necessity are the following: Arms and ammunition; aluminum ware; automobile parts; brass goods; buttons; compositions such as celluloid, bakelite, hard rubber, etc.; cutlery; die casting; drop forging in steel, bronze, brass, etc.; electrical appliances, glassware, pressed or blown; hardware; harvesting machinery; horseshoes; jewelry; lighting fixtures; medals; metal wares in general; paper goods; silver, flatware and hollow ware in all its branches; surgical instruments; toys, dolls, etc.; tractors; valves and fittings.

When the enormous expansion and development of the industries enumerated is borne in mind, the greatly increased demand for dies and die production is readily understood. Quantity output of uniform quality is possible only with machine-tool and die methods, and every manufacturing industry is forced to resort more and more to such methods to offset high labor costs and unprecedented operating expense.

How, then, are the world's die requirements to be satisfied? How, in fact, are the present demands being met? The answer here, as it has been to so many other industrial questions, is, by machinery.

The Various Methods Employed in Die Sinking

The die-making problem has been solved by a development of the carving machine, often conveniently, if inaccurately, spoken of as operating on the pantograph principle—that of the guide or tracer following the undulation of a pattern, causing the corresponding movement of a cutting tool, and thereby reproducing the pattern in the material on which the cutter operates. The greatest difficulty encountered in this work was to retain sensitiveness in combination with heavy cutting.

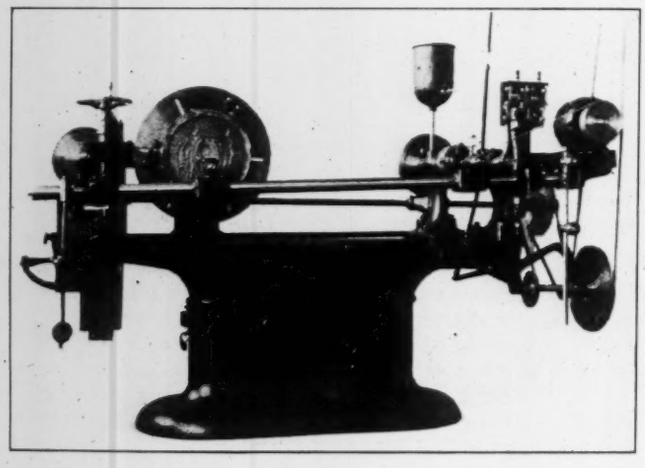

Fig. 1 Small Motor-Driven Reducing Machine Cutting Die for a Medal

Other methods such as machine etching, hot sinking, cold typing, etc., have come up from time to time. Some proved to be quite alluring at the beginning with the usual resultant disappointments after certain inherent difficulties began to be better understood.

The machine-etching method in connection with an electric current, long ago abandoned, is now generally conceded to have been of no practical value.

Hot sinking on the order of the Champney process is still in use to some extent, but its field of application is gradually growing less with the improvement and development of the more positive cutting method.

Cold typing or hubbing has been until recently very limited in scope and could only be used where a small amount of stock was to be upset. An attempt at deep sinking is always accompanied by the risk of splitting, which is usually apparent; or of destroying the steel structure. This latter condition is frequently not noticed until the die has been hardened and put into use.

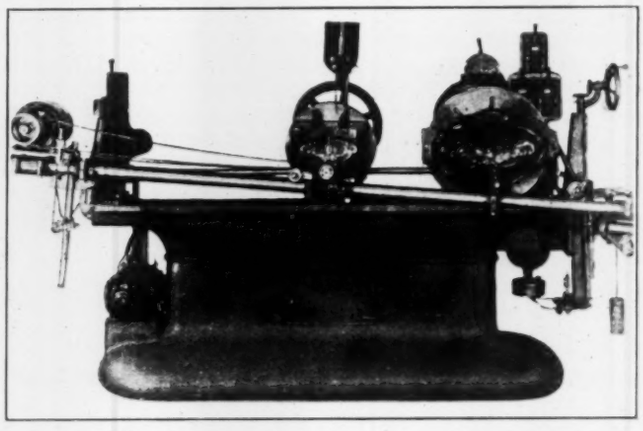

Fig. 2 Large-Size Motor-Driven Reducing Machine Cutting Die for an Ornamental Bowl

In connection with the die-sinking machine, however, the typing method has proved very practicable, and especially useful for silver flat ware, for dies for composition products, and for die casting with multiple inserts, also for many kinds of drop-forge work—in fact, wherever a number of accurate and interchangeable die reproductions are wanted.

The best practice is to cut on the machine a die from an intaglio and a type from a relief model. The die is finished and hardened. The type is then easily fitted to the die and hardened. Subsequent dies are cut on the machine and finished with types with the aid of very little bench work. Although a moderate amount of pressing is done in hydraulic or other presses, so little stock is upset that the steel surface is left in its previously homogeneous state.

In the case of the automatic die-sinking machine, as the model is always his guide, much less skill is required on the part of the operator, although at times it is advantageous to manipulate the hand feeds. The machine follows the master whether hand-operated or running automatically.

Thus the great importance of a method which makes of die sinking an ordinary machining operation. A method by which a pattern is automatically copied in the steel block makes production of dies almost as simple a proposition as if it were a question of making a cast die of iron or bronze.

Automatic Die-Sinking Machines

For convenience of description, automatic die-sinking machines may be divided into two classes: reducing and reproducing—on flat or cylindrical surfaces. Though developed for and applied to many diversified uses, they have all in common the feature of normally automatic operation controlled by pattern or guide.

The reducing machine, or reducing lathe as it has sometimes

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been called, in some form seems to have been the first really automatic machine employed for making dies and molds. In the earlier development these were for a long time confined to coin and medal work and later to such lines as called for work of rather artistic and intricate nature, such as jewelry, silverware and later builders' hardware, etc.

FIG. 3 MACHINE WORK ONLY, NOT RETOUCHED

Fig. 1 shows a small motor-driven reducing machine cutting the die for a medal, and Fig. 2 a large machine of the same type. Both are three-dimension machines in which the tracer follows the details of a large model or pattern to be reproduced in a given smaller size in intaglio or relief.

The lever (or bar) has its fulcrum at one end and is so supported that it has perfect freedom of motion in and out of the various depths of model or pattern and up and down across its face. The third dimension is taken care of through the movement (in this case rotation) of the pattern and work. These are supported on faceplates carried on spindles and supported in brackets on the bed of the machine. These two spindles are worm-and-gear-driven at the same speed and rotate in the same plane. The worms are carried on a splined wormshaft at the back of the machine.

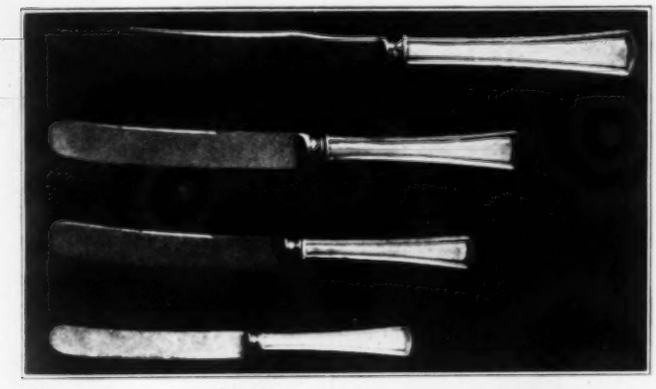

FIG. 4 WORK DONE ON REDUCING MACHINE: A VARIETY OF SIZES CUT FROM ONE LARGE MODEL

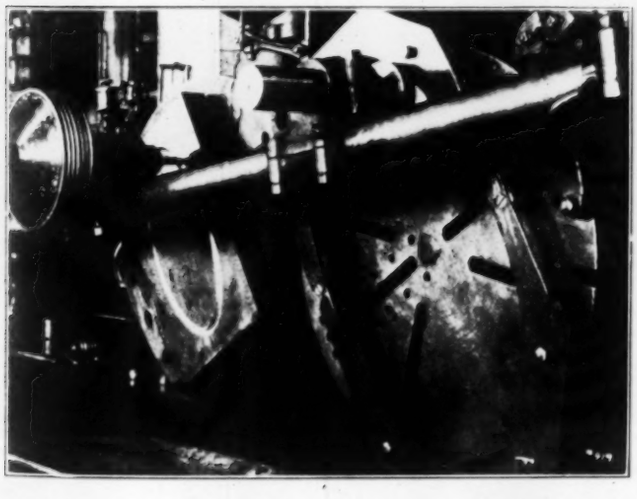

FIG. 5 REDUCING MACHINE MILLING AN OVAL

It will be seen that the work, being located nearer the fulcrum than the model, must necessarily be smaller and in exact ratio as the distance from the center of the work spindle to the fulcrum is to the distance between the model and fulcrum. For convenience in locating the work spindle a scale running from the fulcrum center to the model spindle center is applied to the bed of the machine. As this scale is divided into 1000 equal parts, the use of a very simple formula readily indicates the proper location for the work spindle.

In these machines the model position remains fixed. The work spindle is movable and readily adjusted to any position between fulcrum and model, the point nearest the fulcrum producing the smallest size and the size increasing relatively as the model is approached. The cutter bracket must naturally be adjusted to a point in line with the center of the work spindle.

The free end of the bar is supported on a roller on a screw-controlled saddle at the end of the machine opposite to the fulcrum. With every revolution of the faceplates the cutter bar is moved a predetermined distance. The bar feeds either up or down, depending on the nature of the work. Roller support of the bar helps to keep the friction down to a minimum. A spiral course is traversed by the tracer point and completely covers the surface of the model.

It will here be seen that a speed-controlling device is required so that the tracer may travel over all points of the model at a uniform speed. If the speed selected is correct near the center, it would be too fast at a point on the model further away and the tracer, on account of inertia of the bar, would not reach but would skip the deepest points in the pattern.

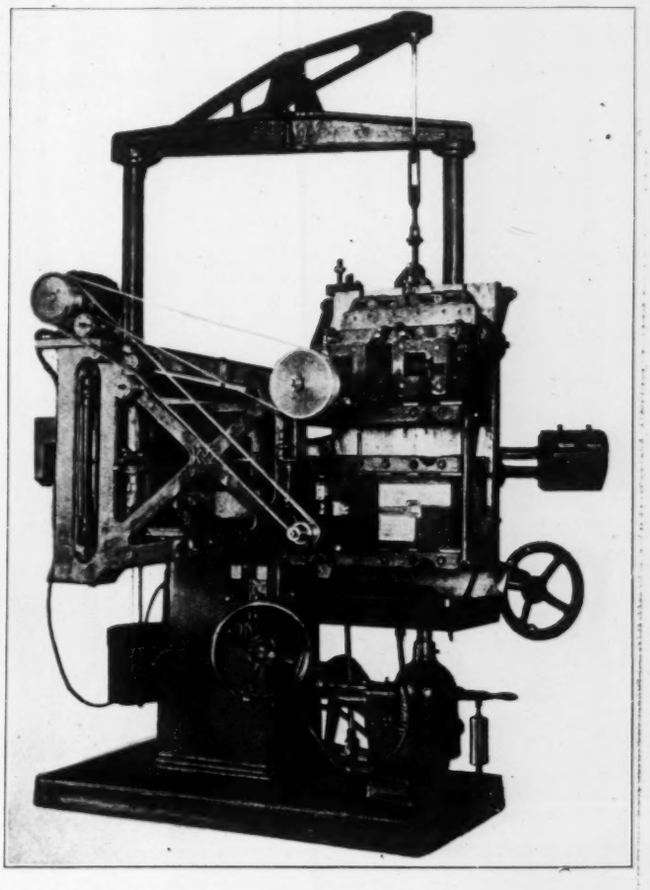

FIG. 6 SENSITIVE DUPLICATING MACHINE CAPABLE OF FAIRLY HEAVY AND DEEP CUTTING

The device employed for this purpose is directly connected through gearing to the drive motor and transmits the power to the worm shaft through the friction of two circular disks with cork inserts which are in contact through the action of a spring when the machine runs at the required speed. As soon as there is a tendency to run faster, the friction disks are separated through the action of a ball governor.

For work of a rectangular or elongated outline an oscillating mechanism was found necessary and developed. This is now accomplished either by reversing the drive motor through a reversing switch or by means of a reversing jaw clutch. In either case the control is through two adjustable dogs carried on the gear driving the model spindle.

Figs. 3 and 4 show specimens of work done on reducing machines; those in Fig. 4, illustrating a variety of sizes, are cut from one large model.

Fig. 5 shows a reducing machine cutting an ellipse. The work comes from the machine exactly to size and much better than when done in a lathe with elliptical chucks, with the added advantage that the machine is not confined to geometric figures as any shape can be cut in this way. Boiler plate about $^1/_8$ in. thick is used for templets.

The bar is suspended and so counterbalanced that the roller on the tracer is always bearing upward and in contact with the model. In this case the regular feed is not used. Size is controlled by using an oversized tracer for the first cut.

Duplicating Machines

The duplicating machine is used in all the lines previously noted which do not call for dies with very fine detail or of highly ornamental design, and in which the detail of the model can be reached with a tracer which need not be very sharp at the point.

The models are easier to make than in the case of the reducing machine, and very frequently there is a model already in existence. Old dies are frequently used as models. Where a piece has been broken off, the gap is filled up with brass or solder.

The fields of usefulness for duplicating machines are much the same as for reducing machines. In addition, however, they are now very generally used in the making of metal patterns and core boxes.

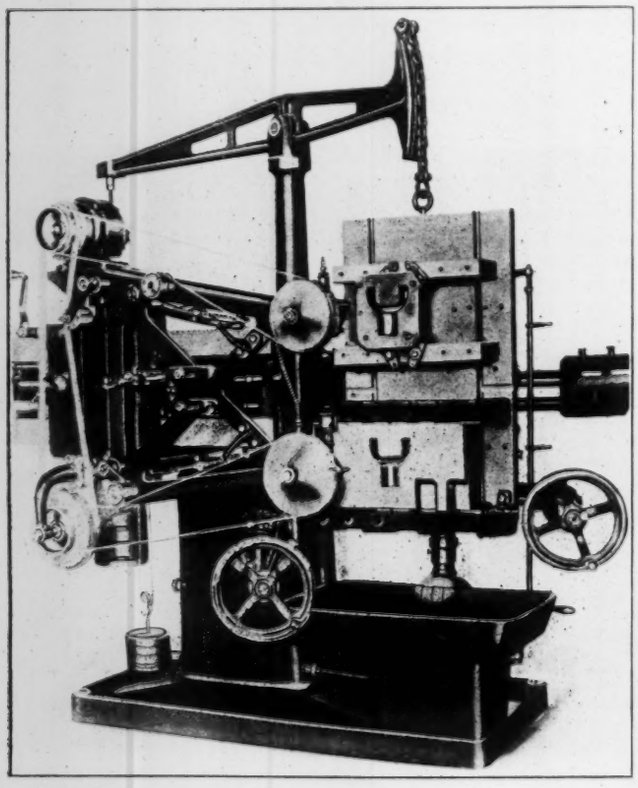

Fig. 7 Heavy Type of Duplicating Machine

Fig. 6 shows a duplicating machine that is quite sensitive and yet capable of fairly heavy and deep cutting. For convenience in counterbalancing the work table travels up and down in a vertical plane, and a saddle supporting a fulcrumed cutter bar moves either right or left at right angles to the plane of travel of the work. The tracer is held in position against the model by means of weights connected to the bar over pulleys.

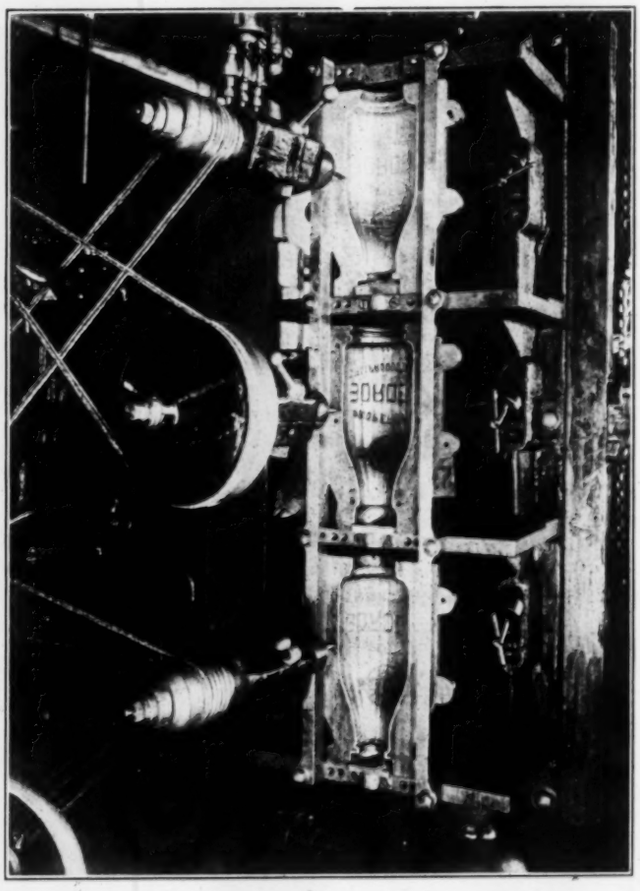

Fig. 8 Portion of Bottle-Mold or Core-Box Machine

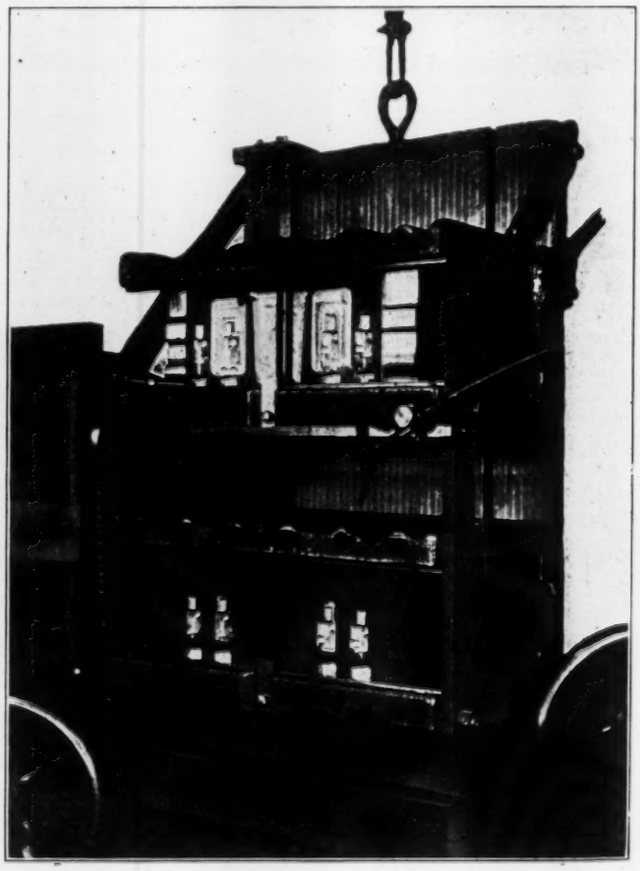

Fig. 9 Fixture for Holding Two Dies and Two Models in one Setting

On this type of machine the cutter and tracer points are alike in size.

The design of the cutter bar and its proper support are of great importance—minimum weight, maximum strength, and above all, sensitiveness. For light work, very carefully made roller bearings are used, with a ball bearing to take up the thrust. For heavy work, pivot centers carefully ground and lapped work best.

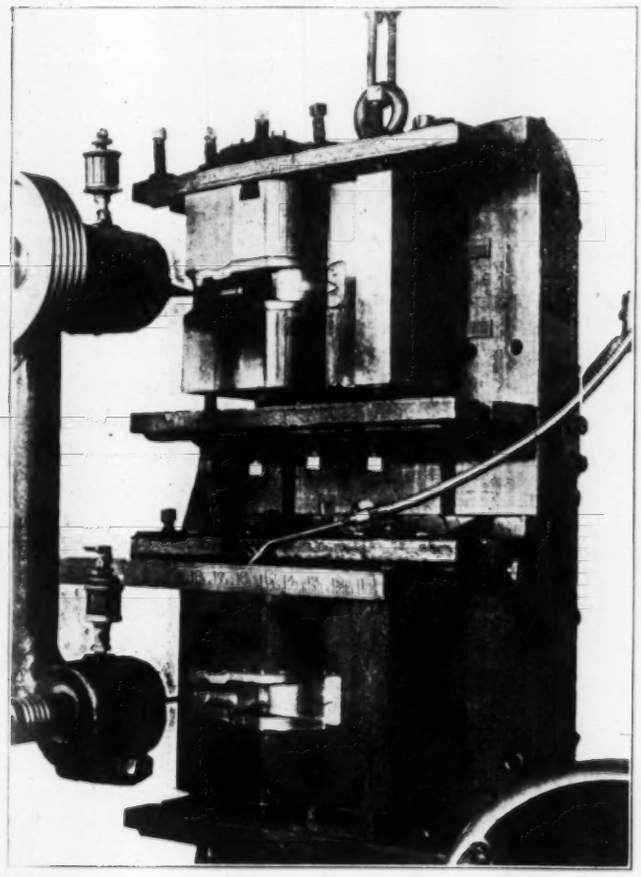

FIG. 10 USING A DIE AS A MASTER

It should be noted here that the model and work are carried on *one* rigid member and the cutter and tracer also on *one* member. There is no change in relation between model and work or tracer and cutter; therefore the accuracy of the result.

Fig. 7 shows a machine the same as that of Fig. 6 in principle and general design but heavier. It is really an automatic milling or profiling machine, but when operated by hand it works very much like the well-known hand-operated die-sinking machines, with the great advantage, however, that the operator always has the pattern to follow. For this reason there is less skill required. The hand feed is used principally for hogging out and setting up the work. In every case the pattern is always followed by the tracer.

Thus by this method the greatest difficulties of die sinking have been overcome. Irregular surfaces present no difficulties.

This machine is capable of heavy cutting to practically any depth of a 12-in. die, and it will machine die blocks up to 27 in. by 16 in. face by 12 in. deep. As the machines run automatically a large part of the time, one man can tend a number of them, the operation being quite simple. In many shops they have been operated in shifts for 24 hours a day.

Fig. 8 shows a portion of a bottle-mold or core-box machine which is similar to those just described but has a centrally located model and cuts two pieces of work simultaneously, one above, the other below, the model. It has variable-speed drive motors automatically controlled to take care of the conditions within the cavity calling for a sudden change of speed. The work table swivels automatically so that the feed may start at the surface at one side of a mold with a half-round cavity and finish at the surface at the opposite side, the work table changing its position in relation to the tracer and cutter automatically but very gradually.

These machines work very rapidly as compared with the old hand methods, cutting a pair of bottle molds in from one to six hours, the molds leaving the machine accurately matched and requiring comparatively little hand work. They are equally rapid on metal core boxes.

A fixture for holding two dies and two models in one setting and which facilitates setting up, is shown in Fig. 9. It is especially useful in quantity production in connection with drop-forge die work. All dies of this class have two sets of matched edges, which are planed square to each other. The dies are placed on the fixed lower jaw resting on the matched edges and brought forward until their faces touch the stops. They are also moved endways either to the right or left until the matched edges touch a side stop.

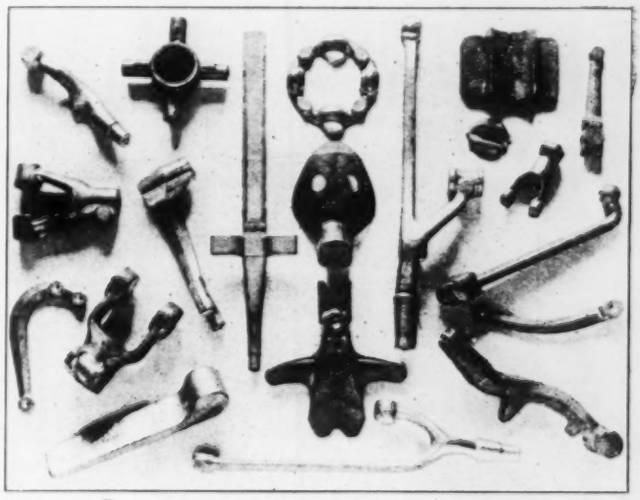

FIG. 11 FORGINGS MADE FROM DIES CUT IN A DUPLICATING MACHINE

The models are held in the same way. The setting-up is quickly done and the corresponding cavities match with accuracy.

Most dies cut on a duplicator or automatic die sinker require a moderate amount of hand finishing (scraping, polishing or chasing), depending on the class of work. There are many cases where dies can be put in use as they leave the machine, without any hand finishing (see Fig. 10). This is well illustrated in the sample forgings shown in Fig. 11.

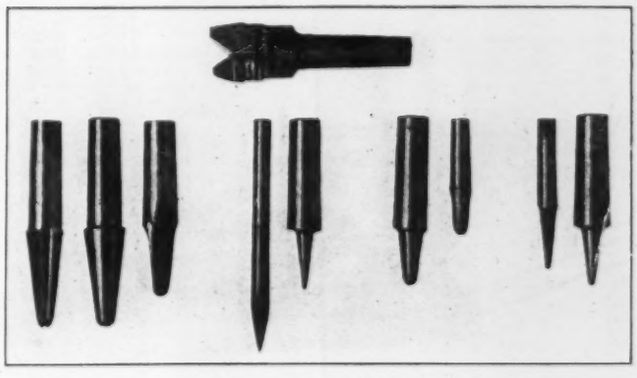

FIG. 12 CUTTERS, MILLS AND TRACER POINTS USED

The cutters used in these machines are quite simple and are of three distinct types as shown in Fig. 12: the diamond point, up to about $\frac{1}{16}$ in. diameter at the point, made of round stock much like a flat drill; the round-nose fluted end mill, from $\frac{1}{16}$ in. in diameter at the point up to practically any size and having two or more flutes, depending on the size; and the formed end mill, used occasionally for spotting, or hub cutting as it is sometimes called.

Until recently hard-metal models have been used on the machines to resist the pressure of the tracer point made necessary in order

to keep the cutter in the work. The reduction of this pressure, so that models of cement, plaster, soft metal or other comparatively soft materials may be used, has been accomplished by means of an electrical control of the cutter.

In the electric-control method the cutter bar is positively operated by means of a lead screw, which in turn is under control of the tracer. The tracer is so constructed that the pressure on the master is only a few ounces, thereby permitting the use of the soft masters. But the cutter bar is positively controlled by the lead screw so that the pressure which can be brought to bear on the cutter is limited only by the strength of the cutter and the capacity of the machine. The in-and-out movement of the cutter bar being entirely dependent on, and controlled by, the action of the tracer on the lead screw, also permits the use of straight-flute mills and the cutting of straight-sided cavities.

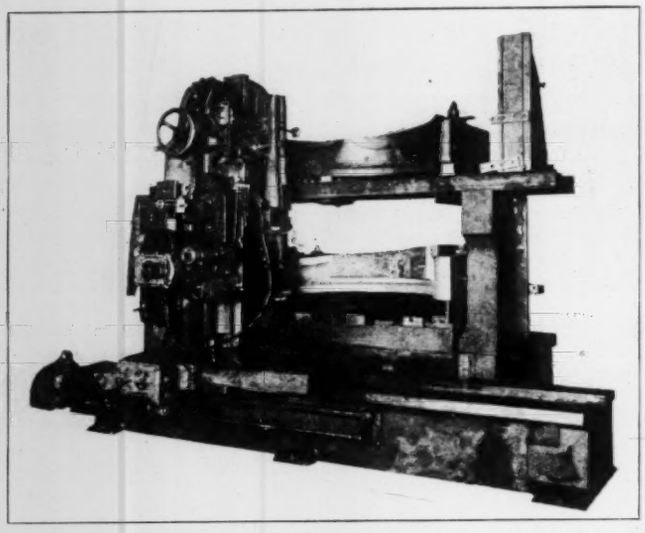

FIG. 13 MACHINE CAPABLE OF TAKING HEAVY CUTS ON LARGE DIES AND PROVIDED WITH ELECTRICALLY CONTROLLED TRACER FOR USE WITH MODELS OF WOOD, PLASTER OR OTHER SOFT MATERIALS

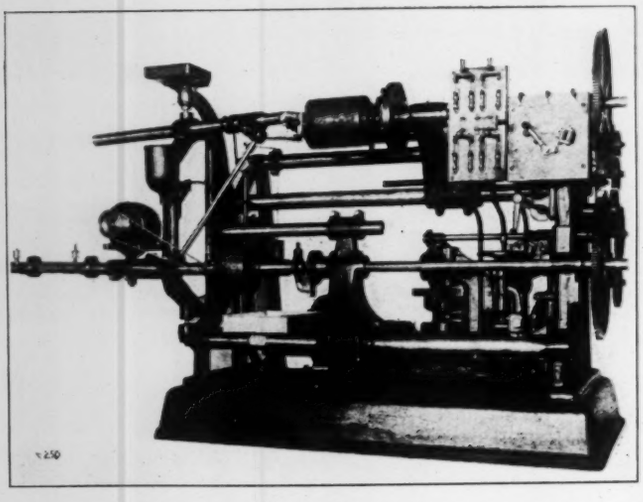

FIG. 14 ROLL-CUTTING MACHINE

This method of electrical control has also made possible the construction of much larger machines capable of heavy cuts on large dies.

Fig. 13 shows a machine of this type operating on automobile fender dies. This style of machine is built to cut the largest dies that can be used for auto bodies, fenders, axles, crankshafts, bath tubs, etc.

On account of the weight of the work it is fastened to the machine bed and remains in a fixed position. The head carrying the cutter and tracer travels back and forth in front of the work and model in a horizontal or vertical plane. The tracer and cutter travel in and out, taking care of the depth of die through the action of the electrically controlled tracer.

ADVANTAGES AND RELATIVE COST OF MACHINE-CUT DIES

The first question that is usually asked is: What is the percentage of saving as compared with hand work? And the second is: How much hand finishing do machine-cut dies require?

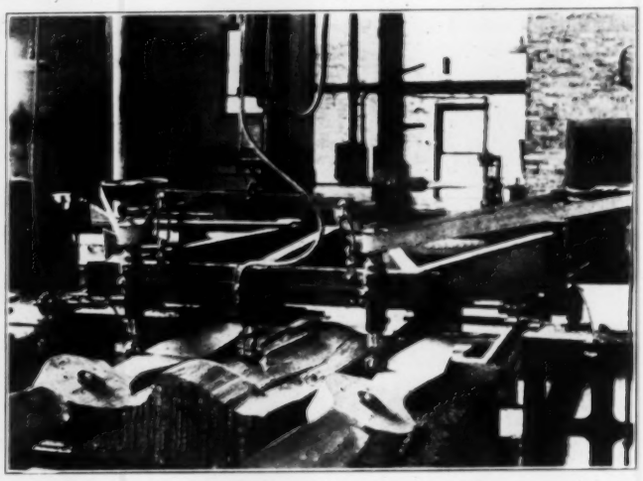

FIG. 15 PROPELLER-CARVING MACHINE

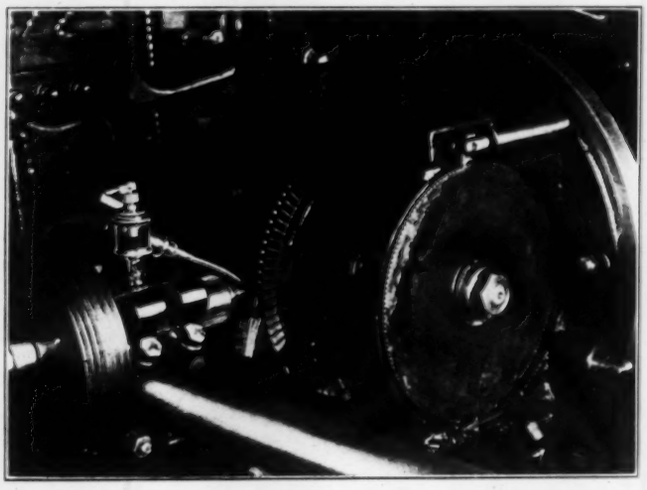

FIG. 16 MACHINE FOR CUTTING BUCKETS ON TURBINE WHEELS

The amount saved with the use of automatic die-sinking machines is translated into figures with difficulty on account of the vastly varying conditions. In most cases it is considerable: the more difficult, the greater the saving over hand work. The average is over 50 per cent and in many cases as much as 80 per cent. Some of the other advantages are:

Having dies when required
Speed
Difficult dies no more trouble than simple ones
Reduced overhead
Convenience in replacing broken dies
A small flexible die department, adjustable to slack periods and peak-load requirements
Uniformity of product.

A method which can afford to disregard what would otherwise be considered prohibitive difficulties, permits the manufacturer to design his dies purely from the production point of view, instead of being limited by considerations of die costs.

In connection with a large Government program it was possible to eliminate a restriking and bending operation by making a rather

(Continued on page 606)

Variable-Speed Motors in Finishing Plants

The Saving in Fuel Resulting from Their Substitution for Independent Steam-Engine Drives, as Shown in the Analysis of the Power Problems of a Typical Finishing Plant

By WARREN B. LEWIS,[1] PROVIDENCE, R. I.

THE perfecting of the adjustable-speed, direct-current motor has wrought a revolution in the engineering economics of the cotton-cloth-finishing business far greater than would at first appear to be attributable to any advantage which might be derived from the substitution of electric for mechanical drive. Twenty years ago the stationary, constant-speed electric motor found its application principally in small shops or in departments of larger shops where convenience was the predominating factor. A few years later any proposal to substitute electric drive for mechanical drive met with a demand for proof of greater efficiency in transmission, and several years elapsed before prospective purchasers would admit that the use of electric drives would produce economies outside of the field of simple engineering economics.

The adjustable-speed, direct-current motor opened up a field in which mere mechanical efficiency was not of prime importance, and established a record for productivity that no other variable-speed device could attain. Since that time the adjustable-speed motor has been considered primarily as a variable-speed device which, by reason of its simplicity, perfection of speed control, etc., has outrun all of its competitors. In this paper it is proposed to show that the usually accredited advantages of the adjustable-speed, direct-current motor are not paramount in its selection for driving certain classes of machinery used in the cotton-cloth-finishing business, but that it has made possible a reduction in production costs that are most striking.

Nature of Power Problems in Finishing Plants

In the manufacture of cotton cloth the power problems are of the simplest character. In the finishing business, however, they are most complex. Finishing plants use large quantities of power, heat and water, and so great are these as factors of cost that the very location of a finishing plant is determined by proximity to ponds or streams which will furnish millions of gallons a day of clean water, and adequate facilities for the transportation of fuel, greater in weight than the total weight of the product shipped out.

If one takes occasion to visit the many finishing plants in New England (exclusive of those which have in the last few years rebuilt their power plants in accordance with the most modern ideas—and these are very few in number) he will find a great number of small engines, either belted, geared or otherwise connected to machines which operate throughout a considerable range of speed; and one or more large engines exhausting to the atmosphere or running condensing, driving through the usual line and countershafts machines which operate at constant speed. He will find numerous drying machines using steam at pressures of from 5 to 10 lb., individually driven by the before-mentioned small engines, the exhaust steam from which passes into the machines and furnishes the heat for drying. Small engines driving machines which, in themselves, do not require heat, will probably be exhausting into a main which will be connected also with drying cylinders, furnishing the steam which those cylinders require in excess of that furnished by the engine which drives them. He will notice numerous blower systems furnishing hot air for drying purposes; and in many cases the heating coils of these blower systems will be supplied with live steam. He will notice numerous dye tubs, jigs and vats which are periodically filled and emptied; and which, more often than not, are supplied with cold water which has to be heated to the boiling point with live steam.

If he comments at all upon the use of so many small engines, he is sure to be told that the arrangement is a most economical one, inasmuch as all of the exhaust steam from these engines is used in drying processes, and that nothing is to be gained by substituting some drive which uses less steam per horsepower. Having the engineering mind, however, he will speculate on the heat being discharged from the larger engine, either to the atmosphere or to a condenser, and doubt whether the arrangement is as economical as its owner thinks it is. He will at once realize that the actual brake horsepower required for the entire plant does not balance with the heat being discharged from all of the engines, and that there is very evident room for improvement; and he will arrive at the final conclusion that the small engines are justifiable solely as a means of obtaining varying speeds and not as motive power for producing power as a by-product.

In practically every case a survey of the plant will show that the heat exhausted from the main engines is entirely wasted, except for such as may be used in feedwater heaters. Complete analyses of many of these older plants show that from 3 to 5 lb. of coal are used per pound of cloth finished, which indicates at once the importance of the transportation problem and the extent to which the cost of fuel enters into the total cost of finishing.

As far as electric drives are concerned, the constant-speed machines in a finishing plant may be disposed of briefly, as the problem is very simple and varies only in degree from that which applies to any manufacturing process where the power required to drive the machines should cost a minimum. The same arguments apply, such as lower transmission losses, ability to reduce losses to zero when machines are not in operation, ease of control, cleanliness, etc.

If a perfect balance can be maintained between power requirements and the demands for heat, then there is little more to hope for in that particular direction; or, if in the production of power all of the heat units passing away from the engine can be utilized, then also the desired goal has been reached. Again, if all of the power required can be produced and the heat discharged from the engine be sufficient for process purposes, then the condition is still better because it is always possible to introduce live steam with the least possible loss between the boiler and the point of use. The adjustable-speed motor has not only made this condition possible, but has actually realized it in plants which have become completely electrified.

Motors as Variable-Speed Devices

The adjustable-speed motor is an ideal speed-changing mechanism. The degree of variation which may be obtained is greater than in any mechanical device, the ease with which the variation may be obtained is ideally simple, and the efficiency is high. Consider it not as a motor, replacing some other form of motive power, but as a speed-changing device introduced between a relatively efficient prime mover and the machine to be driven. Originally designed primarily for machine-tool operation, it was designated as a constant-horsepower motor, inasmuch as it was generally operated at high torque when running at low speed and at low torque when operating at the higher speeds. As a matter of fact, at the lower speeds its rating was somewhat decreased owing to the poorer cooling effect with low armature speeds, and the greater heating of the fields with full voltage applied to them. A four-to-one motor, rated at 10 hp. between the speeds of 400 and 1600 r.p.m. would perhaps be better rated at 8 hp. from 400 to 600 r.p.m., and at 10 hp. from 600 to 1600 r.p.m. at the same temperature rise.

As applied to finishing machinery, however, the adjustable-speed motor is more nearly a constant-torque motor. With few exceptions, it is coupled to a machine which requires a fairly definite torque which does not vary. The horsepower developed by the motor therefore varies with the speed; and if the torque was exactly constant, the horsepower would then vary directly with the speed. This means that the motor operates at its rated horsepower at the

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[1] Consulting Engineer, Mem. Am.Soc.M.E.; President Providence Engineering Society.

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highest speed, and at a low horsepower at low speeds. This has both advantages and disadvantages. At the low speed the torque being no greater than at high speed, the reduced armature heating offsets to a certain degree the heating in the fields due to the full field current. On the other hand, at high speeds the armature takes maximum current when the field is weak, which magnifies commutating troubles. The commutating and compensated field motor has practically eliminated this trouble, however, so that these motors will develop full horsepower at the maximum speed continuously and give perfect service.

It has been found that in 90 per cent of the cases a two-to-one motor will give all of the speed variation that is necessary for general use; while below the normal speed, lower speeds may be obtained for threading up, cleaning, etc., by the use of armature resistance, which, by reason of the low horsepower used for so small a proportion of the time, does not affect materially the overall economy of the plant. This makes possible the use of a smaller and more efficient motor for the usual working ranges.

Note that the losses in an adjustable-speed motor operating under constant-torque conditions decrease nearly proportionately with the horsepower, and then consider this adjustable-speed motor as a device placed between the machine to be driven and the main power unit which will develop a horsepower on about one-third of the steam required by the small engine. Combine the load of all of the adjustable-speed motors on to one generating unit, and the result will be a fairly uniform load and practically a uniform steam economy in the prime mover. Compare this with the varying load of the individual small engines in which the heat efficiency is constantly varying, and it requires very little imagination to see where we are being led.

Analysis of a Typical Finishing Plant

Applying now the general principles set forth in the foregoing to a concrete case, the author will attempt to analyze a finishing plant having a capacity of about three thousand pieces of finished goods per day, two-thirds of which are printed and the other third finished as plain white goods and dyed goods. This is an assumed plant for several reasons; but the principal one is that it is fairly typical from the engineering standpoint.

For the purposes of this paper the equipment of such a plant may be divided into two groups, namely, machines which operate generally at constant speed, and those which operate at varying speeds. The latter being the most important to consider, may be enumerated as follows:

	Max. Hp. of Unit	Max. Hp. of Equipment
Three singers	6	18
Two mercerizing equipments	25	50
Three sets of white cans	10	30
Two sets of dyehouse cans	10	20
Six printing machines with their drying cans	30	180
Five complete tentering equipments	12	60
On continuous steamer	20	20
Two aging boxes	7.5	15
One set of starch cans	15	15
Two open soapers with their drying cans	30	60
		468

Each of these machines will be driven by variable-speed motive power, i.e., 27 individual steam engines or 27 electric motors, and their total maximum requirements will be, as given in the preceding table, 468 hp. when operating at their maximum speeds.

Under no circumstances will all of these machines be running at maximum speeds simultaneously, and therefore requiring maximum power. Extensive experience with this class of machinery has proved that the load factor, as it might be termed, is about 50 per cent, and that while any one or even a number of machines may be operating at maximum speeds simultaneously, others will either be operating not at all or at low speeds.

The constant-speed machines in this same plant will require 600 i.hp. if the machines are driven from lineshafts, of which about 50 per cent will be friction losses. If driven with individual motors, the load will be about 250 kw. This great difference will not be due entirely to the difference between mechanical and electrical losses of transmission, but in great part to the fact that the constant-speed machines will be operated more or less intermittently.

A condition is assumed here which was almost universal up to the advent of the adjustable-speed motor, namely, that the twenty-seven variable-speed machines are driven with twenty-seven small steam engines and the constant-speed machines driven through lineshafting from a simple non-condensing engine. The boiler plant consists of a number of horizontal return tubular boilers, and the average output is 70,000 lb. of steam per hour, about one-third of which is delivered as live steam to processes where high-pressure steam is used.

Condensation in Steam Piping

There are many hundreds of feet of live- and exhaust-steam pipes around this plant, necessitated by the fact that the small engines and process machinery are widely distributed and steam must be delivered to them and exhaust steam taken away from the former. Numerous charts taken from boiler-feed meters will show that the condensation in the steam-piping system will be 10,000 lb. of steam per hour for every hour that steam is on the system, which may and frequently does mean twenty-four hours a day. No material reduction can be made in this loss, except through the removal of all of the piping that is not actually essential to the driving of the machines.

The substitution of the adjustable-speed motor makes it not only possible to eliminate this part of the piping system, but to reduce the sizes of pipes carrying live steam to processes. It is seldom that live steam at a pressure of over 50 lb. is required in the processes; and therefore, with the elimination of the engines, the drop in pressure between the boilers and the processes can be madd 50 per cent or more. Or, still better, the boilers may be divided into two batteries, one group being operated at 150 lb. or more and delivering steam to the main unit and boiler-feed pump, while the other group may be operated at pressures of from 80 lb. down. As a considerable variation of pressure in steam for process purposes it is not detrimental, advantage can be taken of the heat stored in the furnaces and in the water within the boilers, so that during periods of heavy drafts the fires will not have to be pushed to maintain steam pressure, while at the slacker periods heat will be stored up.

This has been done in several plants with the result that the evaporation per pound of coal for the group of boilers furnishing live steam for processes has been very much improved. This again, has been possible through the introduction of the adjustable-speed motor in place of the small engine.

The heat distribution under the conditions stated may be shown by diagram as in Fig. 1, in which the area of the circle corresponds to a boiler output of 70,000 lb. of steam per hour at 100 lb. gage pressure, feedwater being taken from any source of supply at an average temperature of 100 deg. fahr. and heated to an average temperature of 170 deg. fahr. The question may immediately arise as to why a temperature of 210 or 212 deg. fahr. is not assumed; and the answer is that in practically none of these older finishing plants is the feedwater even heated to a temperature of 170 deg. fahr. This is probably due to the fact that a heater with sufficient surface to raise the temperature of the entire boiler feed from 100 to 210 deg. fahr. would be very large; and with the usual exercise of false economy, heaters of about one-half of the needed capacity are used.

Referring to Fig. 1, the area of the segment A represents the amount of steam which is condensed in the piping system. This figure is taken from actual boiler-feed charts in four plants of approximately the productive capacity of the one that we are considering. The area B is the amount of steam taken by the main engine and is based on 25 lb. of steam per i.hp-hr. The area C is the steam delivered to the small engines. The area D is the steam used as live steam in the processes. Segment B is divided to show the amount of heat which is recovered in the feedwater and the heat which is lost. Segment C shows that of 23,000 lb. of steam delivered to the small engines, 20 per cent is entirely lost in condensation, while the remainder may be used for drying purposes.

Steam Requirements for Drying

The drying operations in this plant will require that each yard of goods be dried three times and will require $1^1/_2$ lb. of steam per pound of cloth dried. The three thousand pieces will average in weight 10 lb. per piece, and the hourly rate of steam used for drying will be 13,500 lb. From the main engine 10,000 lb. of steam per hour are available, and from the small engine 18,400 lb., a total of 28,400 lb., or more than twice that required. While as a matter of

fact it is the exception (rather than the rule) to find a condensing engine doing the constant-speed work, it is apparent that the most economical type of engine would have been the logical thing to have used.

The diagram as presented represents the best condition in that the driers are operating simultaneously with the engines. As a matter of fact, more often than not some of the driers will not be in operation, having completed their day's work before the end of the working day, or not being in use at all in some of the departments, with the result that the steam exhausted from the small engines will not be reduced in so great a proportion as will the uses of low-pressure steam, and a still greater proportion will be wasted. This is particularly aggravated when the printing department is busy and the dyehouse is not, inasmuch as printing machines always exhaust steam greatly in excess of the requirements in that department.

Segment *D* of Fig. 1 presents possibilities for some use of low-pressure steam, which, however, were seldom taken advantage of in the older plants, and not always in those which have been rejuvenated. In those processes where it is necessary to heat water up to the boiling point, water may be preheated to a temperature of 160 or 170 deg. fahr. and stored in tanks, from which it may be drawn for use in the dyehouse or in the boiling process. That this has not been done more generally is probably due to the fact that the cost of hot-water heating and storage systems is high, and there are difficulties in conveying hot water which are not easily surmounted. It is far better, therefore, to be able to use all of the exhaust steam for direct heating.

This leads up to the general statement that the whole problem of producing power in a finishing plant has been attacked from the wrong end. Analyzed properly, one should first determine the amount of low-pressure steam which can be used economically, and then so design the power plant as to derive all of the power required in the process of producing the low-pressure steam. If it is possible to produce all of the power from the minimum demand of exhaust steam, then the most economical balance will have been attained, because live steam may be introduced through a pressure-reducing valve with practically no loss.

Now for the analysis of this same plant rebuilt in accordance with the statement which has just been made, viz., that the power is to be produced from the steam which can subsequently be passed on to processes with the least loss.

If the plant is to be electrified throughout, the constant-speed motor load will be 250 kw. and the adjustable-speed motor load 210 kw. No attempt will be made to discuss the relative merits of a.c. or d.c. generation, this being determined by individual conditions; but for this particular plant it is assumed that a.c. motors are used for the constant-speed work, a motor-generator set to give 230-volt d.c. current for the adjustable-speed work, and a 500-kva. generator which may be either turbine- or engine-driven.

The drying operations in this plant require 13,500 lb. of steam per hour at about 5 lb. pressure. The steamer can use 1500 lb. of exhaust steam per hour if it is clean. The two soapers will use 100 gal. of water per minute, which in the old plant has been heated to a temperature of about 170 deg. fahr. by introducing live-steam pipes into the soaper boxes, requiring 5000 lb. of steam per hour. This work can be done with clean exhaust steam, or it can be done in part by collecting all of the condensation from drying cylinders and pumping it into the soaper boxes, instead of back to the boiler-feed heater. This is merely a matter of comparative expense and ease of control.

To heat the feedwater to 210 deg. fahr., 3500 lb. of steam per hour will be required, this figure being derived as follows: The live steam for processes has been reduced from the former requirement of 22,000 lb. to 15,500 lb., requiring that water be taken from an original source and which may be assumed to have an average temperature of 60 deg. fahr. The remainder of the steam (which will be shown later to be 26,000 lb.) will be made from feedwater which has been collected from the various driers at a temperature of 160 deg. fahr., and this being clean water, it can be returned to the boilers.

The total low-pressure steam uses, then, are 23,500 lb. per hour, exclusive of the steam required to heat the buildings, which, taken over a twelve-months' period, may be ignored as far as having any effect upon the design of the power plant.

To operate this plant 460 kw. of electric energy and 23,500 lb. of exhaust steam per hour will be required. A simple, non-condensing, Corliss, releasing-gear engine, direct-connected to a 500-kva. generator will, between the limits of one-half and full load, develop a kilowatt with 42 lb. of steam at 150 lb. initial pressure and 5 lb. back pressure. A 500-kva. steam turbine will operate at the same steam economy.

The turbine has the advantage of giving oil-free exhaust steam. With some precautions the simple non-condensing engine can be used, the chief problem being to remove the oil from the exhaust steam, through the use of properly designed separators. If the plant is already equipped with a good economical reciprocating engine, it would be perfectly good engineering to keep it in service.

To supply 460 kw. at 42 lb. of steam per kw. will require 19,320 lb. of steam, and 90 per cent of this can be delivered to apparatus that can use low-pressure steam at 5 lb. pressure. This will provide slightly less than 17,500 lb. of steam, whereas 23,500 lb. are required. This is a condition which should be very much sought for. If a set of drying cans using a large amount of exhaust steam is stopped for a time, whereas the power required to drive them represents, with the electric drive, comparatively little steam,

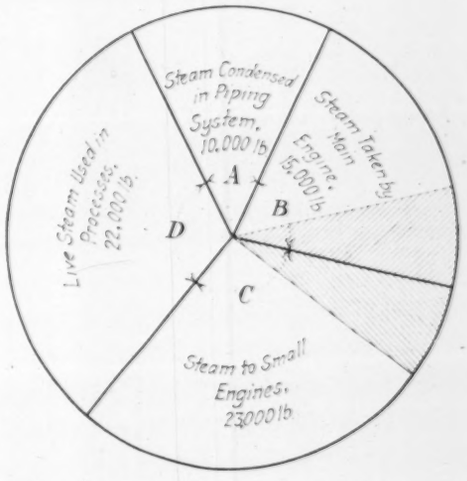

FIG. 1 HEAT DISTRIBUTION IN AN ENGINE-DRIVEN FINISHING PLANT

then there will still be a deficiency of exhaust steam in the whole system, and it is always possible to introduce live steam.

THE COAL SAVING EFFECTED

In this plant the steam-driven units are confined to one prime mover, and the author would even use a power-driven boiler-feed pump, holding perhaps a steam pump as a reserve unit.

The steam used in this plant, excluding that required for heating buildings, which is a very small amount, totals 43,500 lb.; 23,500 lb. will produce all of the power and low-pressure steam required, 5000 lb. represents condensation, and 15,000 lb. the live steam used direct other than that introduced into the exhaust-steam system. This is a reduction of 26,500 lb. of steam per hour required to operate the plant, and it is easily seen that with an average evaporation of 9 lb. of water per pound of coal over a period of 2700 working hours, this will reduce the coal consumption 4000 tons a year; and this is not the whole of it, by any means.

REDUCTION OF LOSSES DUE TO CONDENSATION

Finishing plants do not start up at a specified time in the morning and shut down at a specified time in the afternoon, as do many manufacturing plants. It is the rule rather than the exception that some machines will run overtime, requiring that full steam pressure be maintained on the entire piping system for the benefit perhaps of two or three small engines. It is also the rule rather than the exception that a full steam pressure is maintained on the high-pressure piping system twenty-four hours a day, with the possible exception of Sundays, entailing excessive condensation

losses of more than one-third of the steam which can be accounted for as entering into actual production. With the entire elimination of a large part of the live-pressure steam pipes and a reduction in the sizes of those remaining, not only will the condensation losses be decreased, but it will be possible to shut off the live-steam system entirely when steam at that pressure is not required for high-temperature and boiling operations. Boiling operations carried on at night can be served from a comparatively small live-steam main run directly from the boiler house.

In a certain plant where no printing or dyeing is done, and where the losses through condensation are therefore less than would be found in a plant carrying on all branches of the business, the average boiler load, from 7 o'clock in the morning until 4 o'clock in the afternoon, production being comparatively low, was about 22,000 lb. of steam per hour. For the rest of the twenty-four hours it averaged somewhat more than 8000 lb. per hour. Holiday and Sunday charts in this same plant show about the same amount of water fed to the boilers per hour for the full twenty-four hours. In this case only about one-third of the steam can be accounted for as being directly chargeable to processes.

On another occasion when the plant was somewhat busier, the boiler load was fairly constant at about 30,000 lb. of steam per hour from 7 o'clock in the morning until half past 5 o'clock in the afternoon. From 10 o'clock at night until 6 o'clock in the morning the average rate of feed was 8000 lb. per hour as before.

The maximum boiler load in this particular plant is about 35,000 lb. of steam per hour, so that it is at once apparent that the constant loss of 8000 lb. over twenty-four hours is a very large proportion of the total steam. The remedy for this is to eliminate every foot of pipe which is not absolutely essential and keep steam out of that part of the piping system where it is not needed after the day's work is over.

Influence of Losses on Production Costs

The influence of these constant losses upon the cost of production can be well illustrated by plotting production in yards per week against pounds of coal per yard of cloth finished. Such curves make it at once apparent that as the production increases the amount of coal used per yard decreases at a rapid rate, and probably reaches a minimum when the plant is being pushed to its very limit of capacity. The coal in this case represents nearly the entire mechanical costs, exclusive of repairs, viz., power, heat, light, cost of pumping water, drying and boiling operations, and, in fact, everything which ultimately has to be accounted for in the coal pile. While the adjustable-speed motor can hardly be credited with all of the saving which it has been possible to make in finishing plants, its introduction has made the other things simple of accomplishment. Maximum production on any machine must be the offset to rising labor costs. Finishing machines, operated at varying speeds, are subject to many interruptions, and are started and stopped, or slowed down and speeded up, many times a day. With small engines speeds are rather indeterminate. If a set of driers is slowed down and then speeded up again, there is very little assurance that the speed will be brought back to the maximum permissible at the time, because the eye of the operator is the only speedometer available. With the adjustable-speed motor and its predetermined-speed push-button controller, the running speed is always returned to one definite speed after a slow-down, and a fair degree of assurance is substituted for guesswork.

In some of the processes there are two, and sometimes three, individual machines which have to run in synchronism, the cloth passing through one after the other continuously. With the old mechanical drive the small engine constituted the motive power and the several machines were driven through a series of shafts, bevel gears, pulleys, cone pulleys or Reeves drives, so that the speed could be adjusted to fine limits between the several elements, and then all travel at the same speed.

With the adjustable-speed motor an individual motor can be attached to each element, all operated from one controller, and the speed will be varied uniformly and all elements started and stopped together. This is now the generally accepted method of driving such ranges. If it is desired to operate one element of the range for some particular purpose (as is by no means unusual), then the other motors can be disconnected and the individual machine driven with its own motor.

If the author appears to have been enthusiastic in his presentation of this topic, it is because he has seen the steam consumption of finishing plants reduced to one-half those which previously obtained, and the savings in the cost of fuel pay a very handsome return upon the cost of not only substituting the electric drive but for making all of the other changes in mechanical equipment which could be properly grouped with it.

The Microscopy of Textiles

By FREDERICK J. HOXIE,[1] BOSTON, MASS.

THE microscopy of textiles has not been developed to the extent to which its usefulness entitles it. Methods of imbedding, sectioning and staining yarns and cloth must be developed which will hold the material firmly in its original position while the manipulation is being carried on, as the different parts of the textile are in no way connected when sectioned. For example, the sectioning of yarn so as to show not only the relative position of the fibers, but also the location and arrangement of the starch with reference to the fibers. Mounting and photography also present problems requiring special study, with reference to the diffraction of light.

Imbedding. Celluloid solutions are useful for imbedding, but have the disadvantage of requiring complete dehydration of the fibers before they can be successfully applied. This dehydration renders the fibers hard and difficult to cut into thin sections. Paraffin has the disadvantage of being somewhat opaque and showing crystals if it is not removed before the sections are used for photographing. If it is removed, great care must be exercised to keep the fibers and starch in their original positions. Gelatine and glue, which are miscible with water, have useful possibilities, as the water in the colloidal material of textile fibers is essential to their physical and chemical structure and its removal may make important changes in the appearance of this structure with reference to the diffraction of light as well as its behavior with reference to imbedding media. Freezing may be serviceable, but, so far as the author knows, it has not been much used in connection with textiles.

Sectioning. A specially arranged microtome is desirable in order to cut the thin, smooth sections which are necessary for successful photography. Thick sections do not photograph well, as the difference in the refraction of the materials causes a lens action which confuses the detail, particularly in high-power work. Considerable study and experience is necessary in the selection and sharpening of the razors in order to secure good thin sections.

Photographing. As an auxiliary to successful micrographic study, photography is practically necessary as it not only keeps an accurate record of the observations but facilitates comparison of several similarly treated specimens. In order to carry out micro-photography successfully, considerable study must be given, not only to common photographic methods such as exposure and development but also to the use of colored light by means of color screens or prisms in order to get the required detail and contrast. In many cases red light, while incapable of giving the fine detail of shorter-wave-length light, has the advantage of giving a stronger contrast which is important in demonstrating surface characteristics of goods or fiber. This applies particularly to photographs of cloth at moderate magnification (less than 100 diameters). Such micrographs are particularly useful in showing defects in weaving and dyeing. In such photographs the angle at which the light is applied is important in bringing up characteristics of the surface of

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the cloth, such as the effect of the Schreiner calender used to give cloth, especially when mercerized, the appearance of silk.

With the use of red light it is of course necessary to use panchromatic plates with either special dark-room illumination or no light at all in the dark room.

The arrangement of the camera on the microscope where much high-power work is to be done is of special importance. The author has a camera about twelve feet long with the ground glass in the photographic dark room. Three rods extend from the side of the ground glass to the microscope with handles conveniently located in the dark room. One of these is attached to the fine focusing screw of the microscope, the other two to the mechanical stage so that the specimen can be readily moved back and forward and up and down, the focus being adjusted while the operator remains before the image on the ground glass, which can be comfortably examined and adjusted with external light excluded from the dark room. Up to 1000 diameters photographs can be made with reasonable success with no eyepiece, but the author has recently been making experiments with an eyepiece and magnification up to 4000 diameters. With such high magnification it is

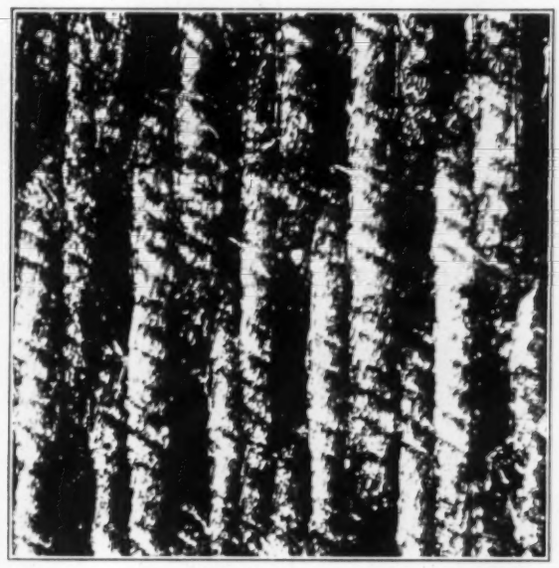

FIG. 1 VENETIANS FINISHED WITH A SCHREINER CALENDER, SHOWING THE DIFFERENT ARRANGEMENT OF THE TEETH WITH REFERENCE TO THE LINES OF THE FIBERS IN ORDER TO GET DIFFERENT FINISHING EFFECTS

difficult to get satisfactory detail, but it may be possible to improve this by using short-wave-length monochromatic light. This, however, makes it difficult to focus the image on the ground glass, as it is difficult to get such light of sufficient brilliancy to clearly impress the eye. A powerful nitrogen tungsten light with condensers makes a convenient illumination.

A useful application of the microscope to the study of cloth is the observation of the effect on the appearance of the goods caused by the uniformity of twist as well as the absolute twist. This is clearly shown by the angle at which the fibers cross the direction of the yarn. This gives a good method of direct measurement of twist if it is not so small as to make the yarn flat and, in this case a fair estimate can be made by making a proper allowance for the flatness.

Very few stains have been studied with reference to textiles. Iodine is commonly used for showing the starch. Polarized light and common textile dyes doubtless have possibilities in studying the inner structure of the fiber. Some common dyes penetrate the fiber only slightly and the yarn scarcely at all, thus causing decided variations in the appearance of the finished goods. This is clearly apparent in photographing dyed yarn sections at high magnifications. Another practical application of the microscope to cloth finishing consists in observing the effect of the angle of the Schreiner teeth on the appearance of the goods and irregular mercerization from various causes, clearly shown in sections.

Many irregularities in textile spinning, weaving and finishing which are now a matter of mystery can, by photomicrographic records, be brought into the realm of fact, and much of the chance in textile manufacture which has possibilities of expensive misunderstandings can be eliminated.

FIG. 2 SECTION OF 120-WARP YARN, SHOWING THE PENETRATION OF STARCH USED FOR SIZING

The general practical value of textile microscopy should cause the technique to grow rapidly and should bring about lively interest

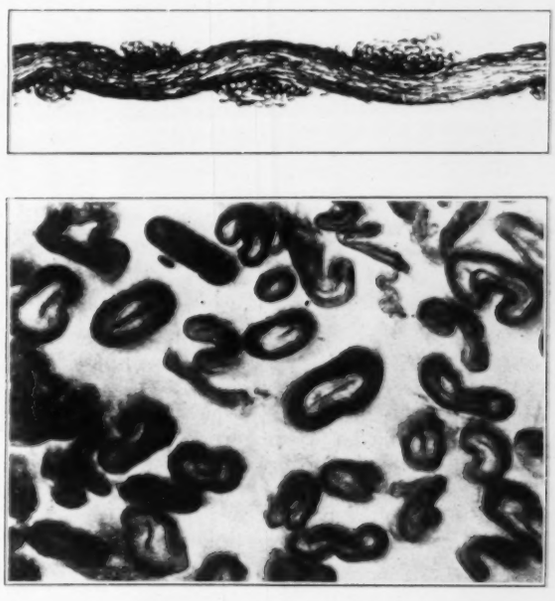

FIG. 3 SECTIONS OF RED COTTON YARN DYED WITH PARA NITRANILINE, SHOWING THE MORE COMPLETELY DYED FIBERS ON THE OUTSIDE OF THE YARN AND THE LESS COMPLETELY DYED FIBERS INSIDE, ALSO VARIATION OF PENETRATION OF DYE IN INDIVIDUAL FIBERS

and profitable discussion which will doubtless center about schools and colleges in which the study of textiles is carried on, and can very properly be developed in the botanical departments of colleges where such departments already exist.

Figs. 1 to 3 give some idea of a few of the possibilities in the application of microscopy to the problems of the textile manufacturer and finisher.

Winding as Related to the Textile Industry

Modern Methods Employed in the Preparation of Filling Yarn and the Saving in Weaving Costs Resulting from Their Employment

By GEO. W. FOSTER,[1] PROVIDENCE, R. I.

OUTSIDE of the electrical field, winding is almost exclusively a textile process of intermediate or preparatory form, and it can be definitely classified as an art of transferring fibrous, thread-like material from a small-capacity container to one of determined form having larger capacity, the fundamental idea of such transfer being to provide long lengths of inspected yarn or thread of other intermediate or final processes, in order to establish a more effective and continuous operation of the same.

The science of winding rests in the principle of ratio between a revolving element, as represented by a package, and a reciprocating element, as represented by a traverse guide, and it is through establishing a correct speed relationship between the two elements that yarn or thread is laid in binding spirals to form a self-sustaining body of material.

While winding was understood in England fifty years ago, yet it could hardly be classified as an art until the year 1890, at which time we started to build winding machinery in this country, and it can be truthfully claimed that real development in the art and its application to the textile industry date from that period, to the credit of American engineering genius and American progressiveness.

Types of Winding Machines

Winding can be classified under two heads, and is represented by two types of machines, one known as the friction or drum-driven (where the package is revolved by surface contact with a cylinder or drum), and the other as positive-driven (where the package is revolved by force applied to its axis). The difference between the two types lies principally in the manner in which the yarn or thread is laid throughout the package, it being obvious that in one case, where the package is frictionally driven, the ratio between the package and the traverse guide is constantly changing, with a resultant change in angle of the thread being laid, while in the other case, where the package is positively driven, the ratio between the package and the guide remains constant, which results in a continuous winding precision of predetermined form.

In the foregoing the author has simply endeavored to outline the art in general. What is of greatest concern is the relation of the art to the industry, and its manifold applications for economic gain.

Winding Yarn for Outside Consumption

Winding machines were first developed for that branch of the industry manufacturing single and plied yarns for outside consumption, and second, for that branch of the industry where the wound product is used as a supply to improve qualities and cheapen costs of subsequent processes within the mill.

Conical packages may be taken as a concrete example with which to illustrate the entire field of winding which applies to that branch of the industry making yarns or threads for outside consumption.

In the early days knitting yarns were spun on mule frames into cop-like form, it being the practice to pack in a case five or six thousand of these small cops for shipment to the hosiery and underwear trade. As a cop weighing only three to four hundred grains was too small and uncertain a supply to use direct, the customer was obliged to rewind the yarn he had purchased on to what was known as a bottle bobbin, in order to get long lengths of material for his knitting machines.

This proved to be a very unsatisfactory and expensive method, for not only did it call for numerous handlings of many small containers, but the very handling and shipping of so delicate a product tended to destroy its form and usefulness. The inevitable result was a considerable loss in valuable time and valuable material, which resulted in friction between manufacturer and consumer, as to which one should stand the loss.

Today the manufacturer takes his yarn from mule or frame direct to a winding machine where the yarn from fifty to a hundred spun cops or bobbins is pieced together to form one continuous inspected thread. The conical package into which this length of thread is formed is then carefully wrapped and sometimes sealed in paper, compactly packed in a case and shipped to the knit-goods manufacturer. The customer opens his case, draws off the paper wrapping, and finds instead of a mutilated cop a perfectly formed supply of great length, which can immediately be utilized for his requirements, there being no waste and no handling process. This amounts to an economic gain; it cannot be otherwise.

For this branch of the industry many various types of winding machines are being made to wind nearly every conceivable kind of material of fibrous or thread-like nature; cotton, worsted, woolen, linen, silk (real and artificial), jute, sisal, hemp, asbestos, paper, braid, tape, and even human hair from China representing some of the materials wound for commercial purposes or outside consumption. The product of the machines that wind these various materials vary from a small quill of fine weaving silk weighing possibly 250 grains, to a parallel-tube package of ½-in.-diameter cord or rope weighing 70 lb.

As the author sees it, the most interesting phase of winding lies in its functional relationship to subsequent processes in yarn and cloth manufacture, or in other words, a direct application of the art for inside absorption rather than outside consumption. The development of winding as an art for this branch of the industry has been no simple matter, but a long up-hill fight, for it has not been a question of meeting outside commercial demands which a mill agent or treasurer can readily understand, but rather a question of coping with inside conditions which are always difficult to change in the face of precedent, practice and self-satisfied management.

One of the greatest engineering problems rests in the ability of our textile engineers to convince mill agents and mill treasurers (particularly the latter) that "there is as much in picking up as there is in digging," and that the longer road to the objective is oftentimes the more attractive and profitable; furthermore, that applying engineering principles to industry for economic gain as well as material profit is much more creditable than gaining these profits through adjustments with labor and strictly commercial activities.

It is not the intention of the author to convey the impression that winding as a preparatory process will effect the millennium in the textile industry, for it is only one issue to the point; however, it has been established that winding processes substantially improve qualities, reduce costs and make jobs attractive for men and women who work and buy.

The three elements in a weaving process are the machine, the material and the human, and it is the coördinate relationship of the three that directly affects production, cost and quality.

In weaving, two elements are embodied, the warp and the filling. Warp yarns formerly were, and now are, prepared in long lengths for weaving, by first spooling, then warping, and finally slashing, thereby presenting to the loom thousands of yards of thoroughly inspected material, representing one of the two elements referred to. The other element—the filling—has only recently been given the same careful preparatory treatment accorded to the warp, the practice in the past having been to perpetrate the error avoided in the warp by injecting into the filling process two or three hundred grains only of uninspected material, which by the law of averages and proportion is negative to the warp element with which it is to be mated.

To offset as far as possible this unequal condition and inconsistent practice, a positive-driven type of winding machine was developed to wind filling with compact precision from mule cops or

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frame bobbins on to a paper or wooden container holding two or three times the amount of yarn usually presented to the loom, the process of winding improving the filling, even as the preparatory processes improve the warp, with the result that both material elements are presented to the loom in maximum lengths of equal completeness.

In order that it may be fully appreciated just how this treatment of the filling affects the machine and human factors in the weaving process, and its ultimate effect on the two outstanding economic problems previously referrred to, a comparison of past practices with present methods will be made.

PAST MILL PRACTICES AND PRESENT METHODS COMPARED

In past mill practice the amount of yarn wound on a mule cop or frame bobbin seldom exceeded 350 grains, and if the mill were weaving 40-in. sheeting, 80 x 80 square, 30s warp, 40s filling, the loom running at 160 picks per minute, the amount of 40s single filling consumed per loom per week would equal 14 lb.

Under these conditions a weaver would be given eight plain looms to run, the total job consuming 112 lb., or 704,000 grains of filling, every 48 hours. Dividing the total grains consumed by the grains wound on one cop or bobbin, proves that the eight looms must stop 2240 times weekly for filling changes, and that the weaver must charge and change shuttles an equal number of times, providing the yarn on every cop or bobbin runs its entire length without breaking. As a matter of fact, the total number of interferences would equal 2400 instead of 2240, due to imperfections in the yarn, stuffing from the containers, and the amount of material usually left on the cop or bobbin butt.

By direct comparison, this mill, winding and preparing its 40s single filling, would present to the loom a bobbin containing 875 grains, or 4200 yd. of inspected material, with a result that the eight looms would only stop 896 times instead of 2400, the weaver charging and changing shuttles 896 times against 2400 in 48 hours, there being no additional interference through imperfections, stuffing, etc. The difference in loom stoppages between the two methods equals 1504 interruptions weekly, amounting to a considerable saving in machine and hand time.

Ordinarily, seven or eight seconds is ample time to charge and change a shuttle with bobbin filling, and 14 to 16 seconds the time to charge and change cop filling; however, this does not hold true if the weaver is occupied mending warp, and it is quite possible for looms to be stopped minutes instead of seconds if the weaver is not in a position to make the filling replacement. In this connection it must be borne in mind that 875 grains of inspected filling will run 22 consecutive minutes in a loom weaving 40-in. goods at 160 picks per minute; consequently, when a weaver is mending warp the remainder of the job is more likely to be running.

If 1504 represents the actual reduction in the filling changes, and eight to sixteen seconds the time lost per change, figures prove that 3 hours out of 48 hours would be saved, as compared with frame-spun filling, and 6 hours as compared with cop filling. While this saving fairly represents the additional time allotment for operatives, it does not represent the complete saving in machine time. For illustration, saving 3 to 6 hours of the operative's time, plus the greater continuity of loom motion, represents the improvement for estimating increased loom efficiency.

SAVING IN MACHINE AND OPERATIVE TIME BY NEW METHODS

In actual mill practice this saving in machine and operative time results in an increased loom efficiency of 10 to 20 per cent, as compared with frame- or mule-spun filling, which is equvialent to adding that percentage of looms to a mill equipment without initial cost or yearly operating expense.

With long lengths of prepared filling loom jobs are increased from 50 to 100 per cent, depending on the style of goods being woven. On the 80 x 80 style sheeting previously referred to, a weaver running twelve looms would only charge and change shuttles 1344 times weekly, as against 2400 times on eight looms with a 350-grain spun supply.

Under this improved condition, a weaver running twelve looms would only charge and change 36 shuttles per hour, less than 10 per cent of the 60 minutes being occupied in this respect. Furthermore, it has been definitely determined that the higher loom efficiency previously accounted for is not lost when the job is increased in reasonable proportion to the saving in hand time. Increasing a loom job 50 per cent naturally increases operative productivity in like proportion, plus the higher efficiency of each loom, figures and facts proving that the physical burden, or hand time, on the 12-loom job is considerably less than the burden or time on the 8-loom job, where continuous filling changes are constantly interrupting both machine and operative.

In the foregoing the effect of a preparatory process on the machine and operative factors in the weaving process has been discussed and it now remains to show how prepared filling improves quality and saves waste in materials.

As far as improvement in quality is concerned, it is obvious that the fundamental principle in cloth construction calls for the greatest continuity of loom motion that it is possible to establish. Mispicks, thick and thin places, loops and cracks in the selvage are the results of filling changes which interrupt the harmony of loom motion and it follows that any method effecting a 60 per cent reduction in these changes must operate for refinement and quality. Furthermore, slubs, bunches, and soft and thin places in yarn are likely to be woven into the cloth unless removed in a preparatory process.

Filling waste made in weaving is the source of enormous losses in the textile industry, amounting to millions of dollars annually. The author ventures to say that when mule-cop filling is used 8 oz. of waste represents the loss per loom per week, and when frame bobbin filling is used 4 oz. would be a conservative estimate.

Few mill men like to admit their losses in this respect, and it is difficult to convince them that this waste represents a loss considerably in excess of cost value.

During the latter part of the war, when 100s single yarn was selling for $4 per lb., a certain mill weaving average 100s single filling on mule cops was making, according to their waste account, 7 oz. of cop waste per loom per week, and as they operated 4000 looms, the total loss amounted to 87,500 lb. per year. If the cost value of 100s single yarn equaled $2.50 per lb. and the value in cloth equaled $4.20 per lb., this mill lost $218,750.00, plus a possible profit of $148,750.00, totalling $367,500.00; deducting the amount of $10,500.00 received for waste, the net loss, as the author prefers to figure it, was $357,000.00 per year. It is fair to assume, however, that 87,500 lb. of waste cannot be collected and salvaged without considerable expense.

Similar losses, by degree, appear in all weaving processes, and are caused by constant filling changes brought about through short lengths of imperfect and impaired material being injected into the process, and it will be generally agreed that this fairly represents an economic loss.

When filling yarns are wound and prepared for weaving, one-half of one per cent waste is made in the winding process, but no waste whatsoever is made at the loom; consequently valuable materials are woven into cloth for a greater turnover.

When filling yarns are spun for a winding instead of a weaving process, it is usually the practice to spin a greater amount of material on the cop or bobbin by either changing the builder motion on the mule, or by changing the size of ring on the frame. Taking the 40s single filling previously referred to as an example, past practice would spin this count on a $1^3/_8$-in. ring, each bobbin containing 350 grains of material.

The present method would be to spin this number on a $1^5/_8$-in. ring, each bobbin containing 875 grains, or an amount equal to the quantity wound for the shuttle. This equal condition would establish a simple transfer process at the winder, cheapening the cost of that operation. It would also effect a 2 per cent increase in spinning efficiency, due to the reduction in doffing changes, and it follows that bobbin equipment and bobbin transfer charges would be reduced all along the line by the lesser number of containers involved.

As the author sees it, the ideal combination for spinning 30s single warp and 40s single filling for 80 x 80 square cloth, would be to equip all spinning frames with $1^5/_8$-in. rings, warp bobbins and filling wind throughout. This would insure great flexibility of spinning equipment, and as it is claimed, the application of filling wind builders to warp frames would insure a 5 per cent increase in spinning production as compared with past practice.

Under this arrangement bobbins containing approximately 875

grains of warp yarn would be delivered to the spooler, there to be inspected, pieced in long lengths and wound for the warping process. (Incidentally, production at the spooler would be increased at least 25 per cent by the overend delivery from filling wind warp bobbins.)

At the same time, bobbins containing 875 grains of filling yarn would be delivered to the filling winder, there to be inspected, pieced in long lengths and compactly wound for the shuttle. Under these conditions, and only so, can warp and filling yarn be truly mated in a weaving process.

APPLICATION OF PRINCIPLE OF PREPARATION TO AUTOMATIC WEAVING

While the author has so far applied the principle of preparation to plain loom weaving, it is not be to inferred that the proposition has less value for looms where the filling is automatically supplied.

Applying a similar treatment to the filling process in automatic weaving, it is interesting to estimate that a weaver running 16 looms with a 350-grain spun supply, must magazine weekly 4800 containers, the automatic features being obliged to function an equal number of times in the transfer of these bobbins from magazine to shuttle. By direct comparison, with 875 grains of wound inspected filling on a bobbin, a weaver would only magazine 1800 containers per week on the 16-loom job.

It is interesting to estimate that if 875 grains of 40s single filling runs 22 consecutive minutes in a loom, a magazine of 24 bobbins would constitute a day's supply. It is obvious that the amount of "feeler" waste made in a week would be reduced in proportion to the difference in bobbin changes; consequently the expense of reclaiming the waste from the bobbins would be lessened in like degree

Bobbin equipment and bobbin replacement expense would be greatly reduced when one bobbin contained 875 instead of 350 grains of material.

It is not contended that rewound filling would effect any appreciable increase in automatic loom efficiency as compared with frame-spun filling; there would, however, be a considerable saving in the hand time, which could be utilized for increasing operative productivity.

As compared with mule-spun filling, it is contended that a preparatory process for automatic-loom weaving will effect all the advantages heretofore outlined in the foregoing plain-loom analysis. Fixing charges and repair expenses on looms, either plain or automatic, are bound to be lowered through a 60 per cent reduction in shuttle or bobbin changes.

A recent application of the preparatory process to worsted weaving brought out some very interesting facts. High-grade worsted serges are usually woven on 3 & 1 box looms, it being the practice to constantly mix the filling by changing the shuttle every other pick, in order to prevent a wavy appearance in the fabric, due to slight variations in the filling yarns. Until recently the practice has been to place in each of the three shuttles a spun bobbin containing approximately 400 grains of filling, totaling 1200 grains in the three shuttles. As the looms were wide and the filling rather coarse, interruptions for filling changes were numerous; consequently, a weaver could only run two looms, while the efficiency of the looms seldom exceeded 80 per cent.

When this proposition was taken hold of, it was found that the same shuttles would easily accommodate a wound bobbin containing 1200 instead of 400 grains of filling (providing this amount of material was compactly wound); consequently, each loom is supplied with 3600 grains, over half a pound of filling yarn in one charging operation, with the result that a weaver now operates six looms instead of two at an efficiency of 95 per cent instead of 80 per cent. The whole situation is pregnant with interesting details.

No figures have been submitted as regards the cost of filling preparation, neither have any of the enumerated savings been reduced to dollars and cents; for in view of the fact that many mills have adopted the preparatory process outlined, and the fact that the method calls for so many readjustments all along the line, the author questioned the advisability of including in this paper any values of a definite nature. He would say, however, that the cost of filling preparation, like the cost of warp preparation, is more than absorbed by the economies superinduced through its use.

In conclusion, he would emphasize the fact that serious competitive conditions will have to be met from many quarters unless the restrictive rules of working, which necessarily limit output, are neutralized by the adoption of such legitimate aid as may be secured in producing quality and volume.

Utilization of Low-Grade Cotton and Staple Waste

BY ELWIN HOLBROOK ROONEY,[1] PROVIDENCE, R. I.

IN an average American cotton crop 50 per cent will be low middling to strict middling, about 15 per cent better than strict middling, while 35 per cent will be below low middling. About one-half of this low-grade cotton is unspinnable unless it can be cleaned. The other half, although spinnable, has been considered so unprofitable due to the loss in waste, the low efficiency of production, and the character of the finished product that it has been thought better to purchase a higher grade of raw material.

The total annual production of this low-grade cotton amounts to three to four million bales. In addition to this there are one-half to three-quarters of a million bales of staple waste. By proper utilization of this low-grade cotton and waste we could increase our supply for standard goods, such as osnaburgs, prints, heavy ducks, carpet warps, twines, etc. by about 20 per cent, or enough to supply more than five million spindles.

There is no excuse for a mill to class its card strips and comber noil as waste, because this waste, so-called, can be cleaned by machinery which separates the cotton from foreign matter, reclaims the stronger fiber, and raises the grade up to that of the original bale. If this reclaimed waste is properly mixed with cotton in a Butler mixer, it cannot be detected in numbers up to and including 40s count. This saving may equal 7½ to 10 per cent of the total investment.

The utilization of the low-grade cotton is of considerable financial advantage, as one cent saved on the purchase price is equivalent to 2½ per cent of the investment in the spinning plant, based on the prewar cost of about $25 per spindle. Some plants in 1920 made profits from 5 to 7½ cents per lb. by cleaning this cotton.

The problem of using this low-grade cotton and staple waste is divided into two parts; first, that of properly cleaning it, and second, of mixing it. If improperly cleaned and poorly mixed, it will spin very badly, and the production will be low. However, machinery is being built today in this country which can properly clean and reclaim any low-grade or staple waste made from cotton above ordinary grade.

Today there are several theories in vogue with reference to cleaning cotton. One is that of trying to develop a modified air blast in combination with Crighton openers, automatic feeders, condensers and trunk systems. Another is known as the reginning process, and still another the Gordon cleaning system. Beating may weaken the fiber, but there is no danger of this in blowing. However, it is impossible to clean cotton with air blasts, and the author believes it must be done by machine. If this is so, a card licker-in or comber half-lap injures the fiber less than any other method and has been used more widely and successfully in cleaning cotton than any other. It is the only one which has been successful in separating foreign matter, such as leaf, mote, etc., from the fiber.

There is a great deal of low-grade cotton in ordinary grades running down into what is known as type cotton, storm cotton, bollies, gin cuts, reds, blues, etc. Much of this cotton is strong in

(Continued on page 606)

[1] Treasurer, Gordon-Hay Company, Providence, R. I.

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Water Treatment for Boilers

Various Methods of Water Softening—Treatment for Excessive Concentration of Soluble Salts in the Boiler—Corrosion of Boilers and Economizers Due to Decomposition of Organic Compounds at the High Temperatures Accompanying Present Steam Pressures and Superheats, etc.

By JULIAN S. SIMSOHN,[1] PHILADELPHIA, PA.

THE subject of water has been generally regarded in the past as a problem for the chemist, so that the difficulties in its use for boiler purposes have hitherto been passed to him, and, based on his analyses and recommendations, chemicals are added in an effort to prevent scale and corrosion, with more or less success.

There were engineering features, however, that should have been considered—questions of boiler circulation, variations in operating conditions, temperatures and boiler pressure—and it was the realization that all these are necessary in the consideration of water for boilers that has placed the problem outside the realm of the chemical laboratory and over into the field of the chemical engineer.

Since the earliest history of boilers, scale formation has always been a source of difficulty and waste, but with low ratings the scale accumulation was quite limited, and that which did form was largely of a porous nature and quite easily removed. Its insulation value made its appearance felt on the coal pile, but the low cost of fuel up to comparatively recent years gave rise to the attitude that the scale situation was not of major importance in power-plant practice.

Modern operating conditions, however, have created new considerations, and high overrating of boilers and intense furnace temperatures, together with the high cost of fuel, have placed water among the important factors in the economical operation of the power plant.

Composition and Properties of Water

From the chemical standpoint water is a colorless, tasteless liquid which is a compound of two parts hydrogen and one part of oxygen, by volume. The nearest approach to it in nature is in the form of rain, which is the condensation of vaporous clouds. As it falls from the clouds as rain it dissolves the atmospheric gases, oxygen and carbonic acid, and, gathering itself together in streams and rivers, it makes manifest its great erosive powers and solvent qualities. It is this rain water with approximately 15 cc. of carbonic acid and 30 cc. of oxygen per gallon that is slowly dissolving away the bedrock of the Schuylkill River, and in such quantities that in the 150 million gallons of Schuylkill water which Philadelphia uses daily, there are more than 50 tons of this rock invisibly moving through the city mains, with a proportion for each boiler. A typical analysis of filtered Schuylkill River water is as follows:

	Parts per Million
Magnesium carbonate	23.0
Calcium carbonate	1.0
Calcium sulphate	66.5
Silica	6.4
Iron oxide and alumina	2.0
Incrusting Solids	98.9
Sodium sulphate	9.8
Sodium chloride	8.2
Organic and volatile matter	5.1
Non-incrusting Solids	23.1
Total Solids	122.0

The mud in the raw river water has been removed by filtration so that suspended solids are not shown in this analysis. The temporary hardness, namely, the carbonates of magnesium and calcium, is represented by only 24 parts per million, while the permanent hardness, namely, the calcium sulphate, is present in much larger quantities. It is important to realize that in most filtration plants alum or aluminum sulphate is utilized in flocculating and coagulating the finely divided particles of mud. While this naturally improves the physical characteristics of the water and permits the tap supply to be clear and colorless, it nevertheless has a very marked effect on the water for boiler use.

Aluminum sulphate itself is a soluble salt and its efficacy as a coagulant depends upon its conversion to aluminum hydrate, the flocculent precipitate, in the following manner:

$$Al_2(SO_4)_3 + 3Ca(HCO_3)_2 = 2Al(OH)_3 + 3CaSO_4 + 6CO_2$$

Therefore, if an analysis of unfiltered river water be compared with an analysis of the same water after it has passed through an alum filter, it will be seen that, though the total hardness remains the same, the permanent hardness will be greater in the filtered water and the temporary hardness will be correspondingly reduced.

The Removal of Temporary Hardness

Temporary hardness can be largely reduced by boiling the water for a few minutes, which will render it more or less opaque; on cooling, a white precipitate will be formed, consisting of a mixture of carbonates of magnesium and lime almost insoluble in hot water. Permanent hardness (sulphate of calcium), however, is unaffected by heat and forms a dense, hard scale difficult to remove.

Therefore, the larger the amounts of alum added at the filtration plant, the more complex becomes the feedwater problem. It is far preferable for plants operating on river fronts to filter their own supply than to introduce into their boilers water with high permanent hardness with its increased scale-forming qualities and correspondingly high cost of chemical treatment. Well waters are usually harder than river waters.

It is not always practical or feasible to depend upon a feedwater heater for the removal of temporary hardness, for the same effect can be obtained chemically by the addition of either caustic lime or soda, which absorb CO_2 as shown by the following formulas:

$$Ca(HCO_3)_2 + Ca(OH)_2 = 2CaCO_3 + 2H_2O$$
$$Ca(HCO_3)_2 + 2NaOH = CaCO_3 + Na_2CO_3 + 2H_2O$$

Neither heat nor caustics, however, have any effect on the sulphate or permanent hardness, and the precipitant for the sulphates of lime and magnesia is soda ash, or sodium carbonate.

Various Methods of Water Softening

The oldest form of water softening, i.e., the Clark soda-lime process, depends upon the removal of the temporary hardness by means of lime in accordance with the reactions already discussed and the removal of the sulphates in accordance with the following formula:

$$CaSO_4 + Na_2CO_3 = CaCO_3 + Na_2SO_4$$

The outgrowth of this principle is the modern chemical water softener, which is nothing other than an external settling tank with such mechanical improvements as to permit suitable means of mixing the chemicals and facilitating sedimentation.

In certain cases the discontinuous principle is used, in which the water is permitted to react with the chemical by standing until the reaction is completed. The precipitated lime and magnesium are allowed to settle and the supernatant softened water drawn off. In other cases the continuous principle is used, where the water and chemical enter at one point and the precipitation takes place along the path of the water.

The completion of any chemical reaction depends upon two factors: temperature and excess of the precipitating agent. In other words, 10 per cent excess soda ash will soften the water much more rapidly than a 5 per cent excess. Further, with any definite amount of soda ash the reaction will be much more complete at 200 deg. fahr. than at 60 deg. in the same length of time. We may expect to find the use of heat, particularly when exhaust steam is available, of decided advantage in water softening (see solubility curves, Fig. 1).

[1] Consulting Chemical Engineer.

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If, therefore, at 200 deg. satisfactory results can be produced with less excess of soda ash, the hot process is advantageous in not only cutting down cost of chemicals used, but also in preventing a more rapid excessive boiler concentration. In very hard waters with, say, 10 grains of lime per gallon and upward, an external treatment is always advisable, but there are many cases where chemicals could be introduced directly into the feedwater heater or the suction of the pump and produce very excellent results with practically no cost for installation. For example, the Delaware River water with about 3 or 4 grains of lime per gallon does not offer much field for the external water softener, which under the best circumstances could only remove about half of the hardness.

Here is the history of boiler cleaning on a 700-hp. boiler at the power station of one of Philadelphia's public utilities:

Aug. 10, 1914	bored 14 rows—entire boiler for inspection
Sept. 23, 1914	bored 2 bottom rows
Dec. 19, 1914	bored 2 bottom rows
Jan. 31, 1915	bored 2 bottom rows
Mar. 12, 1915	bored 2 bottom rows
Apr. 18, 1915	bored 2 bottom rows
May 23, 1915	bored 2 bottom rows
June 30, 1915	bored 2 bottom rows

Aug. 30, 1915, finished boring 336 tubes and 24 nipples. Time consumed, 176 hr.; weight of scale taken out of boiler, 708 lb.

Personal follow-up treatment of boiler feedwater began March, 1, 1916. No mechanical softener was used and chemicals were fed by gravity into the feedwater heater.

Sept. 9, 1916, finished boring 336 tubes and 24 nipples. Time consumed 143 hr.; weight of scale taken from boiler, 258 lb.

Sept. 20, 1917, finished boring 336 tubes and 24 nipples. Time consumed, 21 hr.; scale removed, 92 lb.

Oct. 14, 1918, boiler inspected by Hartford inspector and found in good condition. No tubes bored in 1918.

Oct. 30, 1919, boiler inspected by Hartford Inspector and found in good condition. No tubes bored in 1919.

Oct. 25, 1920, boiler inspected by Hartford Inspector and found in good condition. No tubes bored in 1920.

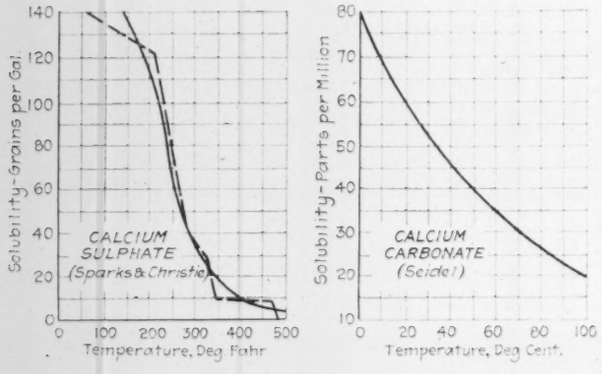

Fig. 1 Temperature-Solubility Curves for Calcium Sulphate and Calcium Carbonate

Prior to March 1, 1916, besides boring the entire boiler annually the two bottom rows were turbined at intervals of approximately six weeks, in spite of the fact that excessive amounts of caustic and soda ash were being used.

Since March 1916, by the use of proper precipitating agents and by varying both the quantity and quality of chemicals to meet variations in the analysis of the raw water, the percentage of returns and other operating conditions, the record has been one of constant improvement with no turbining during the last three years. Such results can only be obtained with the complete coöperation of the chief engineer and a strict adherence to the formulas prescribed and the blowdowns and refills advised.

The so-called "exchange" principle of water softening is based upon a remarkable discovery by Dr. Rudolph Gans, who found that when hard waters are passed through zeolites they are changed in character and become softened. These zeolites are sodium-aluminum silicates and are found in nature as such and can be closely imitated by synthetic compounds. A number of these artificial substitutes are claimed to be superior to the natural zeolites, but this is still a matter of dispute.

All, however, operate on the same general principle, namely, the exchange of lime and magnesia salts for sodium. The magnesia and lime sulphates are converted by this method into sodium sulphate as in the Clark process, but the temporary hardness or bicarbonates of lime and magnesia become sodium bicarbonate. This conversion, while completely eliminating all hardness to the zero point, is of extreme importance in boiler operation, since a certain amount of the carbonic acid from sodium bicarbonate is eliminated by the heat of the boiler and the remaining sodium carbonate concentrates by evaporation.

In waters of high temporary hardness it is necessary to remove a considerable portion of this temporary hardness by preliminary treatment with lime, which makes the process then a combination of the Clark and zeolite processes.

Another absolute method for scale prevention depends upon the process of distillation. It is carried out in the multiple-effect evaporator, making use of the familiar principle of conserving the latent heat of steam and utilizing the steam from the first effect to boil the water in the second. This method has found considerable use in plants where the make-up water is very small and where the elements of expense need not be considered.

In all these cases, however, expense, either of installation of operation, must not be permitted to be the governing factor in the selection of suitable water-softening methods, and the fact that a zeolite softener might be satisfactory and advisable when operating on Delaware River water, is no indication that it should be applied in the treatment of the boiler condition where Schuylkill water is the source of supply.

The complications which arise in the solution of the water problem and the variations which occur in the operation of any plant make it evident how hopeless are boiler compounds in solving the difficulty. The patent-medicine principle is just as incorrect when applied to boiler feedwaters as it is in the healing of human ailments. Many materials used in these boiler compounds are harmful and injurious to the metal and some often guaranteed innocently by their manufacturers to be without effect on boiler metal, do in certain plants where operating pressures are high, corrode the metal and produce serious after-effects.

Deposits on the Boiler Surfaces and Concentration of Soluble Salts

Carbonate of lime when precipitated under atmospheric conditions by heat or by chemical precipitants is a white amorphous precipitate. On standing it becomes crystalline in form, much the same as the mineral calcite, and in the boiler it becomes denser and forms a sludge. Part of the precipitation, however, apparently comes down in the nature of the crystalline form of the mineral aragonite, in which form it is represented in a carbonate of lime boiler scale.

The sulphate of lime becomes a hard, solid, compact and nonporous scale and is usually mixed with variable proportions of the carbonate. Most magnesia salts are finally converted by boiler temperatures into the hydroxide, which then floats to the top together with the carbonate of lime and is carried up with the steam into the steam pipes, engines and turbines. The soluble magnesia content of water is particularly hard to remove since it reacts more slowly with the usual precipitants.

This partially explains why the *percentage* of magnesia in the treated water is a greater *percentage* of the total hardness than in the untreated.

It is useless to attempt to make any statement as to the insulating value of scale in terms of its thickness, and the percentages of fuel losses as indicated in most charts of this character are likely to be exaggerated. It can be stated, however, that hard sulphate scales offer considerably more resistance to heat transference than a carbonate formation. Since, however, the average run of scale represents a mixture of sulphates and carbonates in varying proportions, there can be no definite figure placed on its insulation value.

The soluble salts in the boilers are those which are not precipitated by boiling, and are represented by chlorides and nitrates of lime, together with the sulphates, chlorides and nitrates of magnesia and sodium. Many of these salts are far more soluble in cold water than in hot, and since they are not volatile and do not pass over with the steam, their concentration in the boilers is worthy of attention.

TREATMENT FOR EXCESSIVE CONCENTRATION

It is an easy matter to figure from the analysis of the feedwater and the number of pounds of evaporation just what concentration is reached at the end of any particular time. It is impossible to fix any definite limits as to just where the danger point lies since there are so many factors to be considered, but the consensus of scientific opinion is to the effect that with a 200-lb. working pressure there is no danger of deposition of sodium sulphate or chloride if the concentration is kept below 1000 grains per gallon.

The effective treatment for excessive concentration is blowdowns or the emptying and refilling of boiler with fresh water. Under all circumstances, however, intelligent use of blowdowns can be made to mean much in the saving of hot water, since the heat units with the present price of coal are worthy of every effort of saving.

A fairly accurate idea of the concentration may be obtained if an analysis of the raw water is at hand by knowing the evaporation per hour in gallons, the contents of the boiler, and the number of steaming hours. The author has in many instances checked up the analysis of salts in boilers with the theoretically calculated amounts and found the former figures to differ but slightly from the theoretical.

CORROSION OF BOILERS AND ECONOMIZERS

While the actions thus far considered deal with the deposition of soluble and suspended solids in the boiler, there is another action which may proceed alone or simultaneously, namely, corrosion. As noted earlier in the paper, there is usually present in water either free or half-bound carbonic acid or both, as well as soluble salts, which under the influence of boiler temperatures decompose, producing acids. Such acids, of course, attack boiler metal and corrode it, sometimes uniformly and sometimes locally in the form of pitting.

All organic matter decomposes under boiler temperatures through a series of stages, from the complex molecules until it approaches the simplest, namely, carbonic acid. The speed with which this reaction takes place and the completeness of the conversion naturally depend upon the variables of temperature, rating, boiler circulation, and other salts that are present. This carbonic or weak-acid corrosion usually takes place in economizer tubes, feed lines and economizer drums. The condensate of exhaust steam is always slightly acid on account of the free carbonic acid which is passed over from the boilers together with the oxygen and sometimes other volatile acids. Economizers and the slower-circulating elements of boilers soon become coated with a red deposit or show signs of the formation of rust cones and pitted metal. These cones consist of a black iron oxide center surrounded by a yellow hydrate in a higher state of oxidation. The red deposit is almost entirely hydrated ferric oxide. This type of pitting is very easy to recognize by its barnacle-like formation (see Fig. 2).

Corrosion once started is difficult to arrest, as the action apparently continues for a long time after the carbonic acid has been removed, and it takes considerable alkali to prevent the extension of corrosion when once it has started. The simplest form of relief is the addition of caustic soda to a point where all the free carbonic acid has been neutralized, and the excessive amounts of soda can be regulated by blowdowns.

Another form of corrosion which affects directly the tubes and drums of the boilers is caused by the accumulation of certain salts, more particularly calcium nitrate, calcium chloride, magnesium chloride and magnesium nitrate:

$$Ca(NO_3)_2 + H_2O = CaO + 2HNO_3$$
$$MgCl_2 + H_2O = MgO + 2HCl$$
$$Fe + 2HCl = FeCl_2 + H_2$$
$$FeCl_2 + MgO = MgCl_2 + FeO$$

Such waters in boilers become slightly alkaline on concentration and react pink to phenolphthalein. This is very misleading to the layman, who does not realize that while the boiler may actually be alkaline, there is a corrosive condition existing. This is more true of nitrate of lime, which on concentration shows decidedly alkaline, as compared with nitrate of magnesium, the reaction of which is almost neutral.

CORROSION DUE TO DECOMPOSITION OF ORGANIC COMPOUNDS IN HIGH-TEMPERATURE BOILER REACTIONS

With high steam pressures and high superheats now in extensive use, cast-iron economizers are no longer considered safe, and when steel economizers are employed the corrosion is often accelerated. To relieve this condition there is now being marketed an air-separation process for the removal of dissolved gases, including the objectionable oxygen and carbonic acid. If the hypothesis be true that corrosion is the effect of the hydrogen ion on the iron metal and that the oxygen dissolved in the water reacts upon the nascent hydrogen liberated, then the removal of these objectionable gases should solve the difficulty. The advocates of this process recommend that it be used in preference to distillation, but in this case, of course, the hardness of the water would still have to be dealt with by the addition of chemicals. Furthermore, the author has seen waters apparently free from both free and half-bound

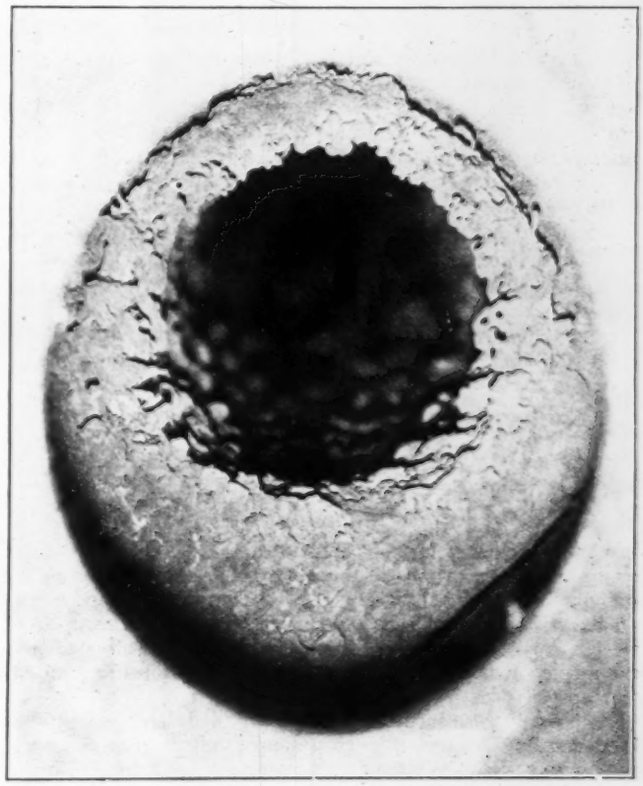

FIG. 2 BARNACLE-LIKE FORMATION DUE TO CORROSION TAKING PLACE IN THE TUBES AND HEADERS OF A B. & W. BOILER USED AS AN ECONOMIZER

carbonic acid which produce CO_2 from the disintegration of organic compounds in high-temperature boiler reactions. In most cases, however, if the temperature of the feedwater is held at about 200 deg. fahr., the dissolved gases are driven off sufficiently to make it possible to treat the corrosive properties chemically.

It is apparent from what has gone before that the correct condition for water in a boiler is an alkaline reaction toward both phenolphthalein and methyl orange. The question as to the concentration of soda ash under the influence of boiler pressure and the degree of alkalinity maintained has created a field for most attractive research. As already stated, water softened by zeolites almost invariably contains free sodium carbonate; also water from all softening systems contains sodium carbonate, and by the constant evaporation of water it is an easy matter to figure theoretically and practically the number of grains per gallon present at the end of any definite period. In the fall of 1915 the author was called upon to treat water in four boilers in a textile mill near Wayne Junction. These boilers were of the return tubular type, approximately 150 hp. each, and the supply was a mixture of Schuylkill River water furnished by the city and varying amounts of well water of about 9 grains per gallon hardness. The feedwater heater

was of the closed type and the small amount of temporary hardness present was practically entirely eliminated before entering the boilers. The particular treatment called for no caustic soda but considerable amounts of soda ash and phosphates as lime precipitants. The boilers operated at about 110 lb. pressure and to the author's surprise an examination of the water at the end of two weeks' operation showed the presence of free caustic soda.

It is general knowledge that at red heat sodium carbonate in the presence of a current of superheated steam is converted into caustic, and assuming this to be 1500 deg. fahr., it is a temperature evidently greatly in excess of any temperatures in an operating boiler. Nevertheless, from work done at this and other plants, it has become evident that with the rise of temperatures as produced by increasing boiler pressures, increasing amounts of sodium carbonate are converted into caustic soda with free carbonic acid, and in the case of condensing units this would be returned again and again to the boilers.

On the assumption that carbonic acid would be found in the condensate water, an analysis would show at about 60 deg. fahr. approximately 4500 cc. of gas per gallon of condensate, whereas the author's experience in numerous samples has ranged from 50 to 95 cc. as a high figure. The thought suggests itself that perhaps the gas had been removed with the air from the air-pump discharge, but since dissolved carbonic acid is not readily liberated until its saturation point, and further, since condensate water is always saturated with oxygen, that cannot be the case.

Of the two possible combinations of carbon with oxygen, CO_2 and CO, the former combines with alkalis to form carbonates and the latter to form formates, and just as red ferric oxide can be reduced to black ferrous oxide, so carbon dioxide can be reduced to carbon monoxide and its salts from carbonates to formates. These combinations may be represented by the following equations:

$$Na_2CO_3 + H_2O = \underset{\text{(sodium formate)}}{NaCHO_2} + NaOH + O$$

$$2NaCHO_2 + H_2O = \underset{\text{(sodium acetate)}}{NaC_2H_3O_2} + NaOH + O$$

$$NaC_2H_3O_2 + NaCHO_2 = \underset{\text{(acetaldehyde)}}{C_2H_4O} + Na_2CO_3$$

In the presence of formate of soda the purple color of permanganate might be expected to be destroyed if added to a sample of boiling water, and by actual test that is exactly what happens.

Soda ash or sodium carbonate, which are not oxidizing agents under normal laboratory conditions, evidently under boiler pressures assume such a rôle and degenerate into sodium formate and free caustic soda.

It is possible to go further into the theory and show that, at about 400 deg. fahr., two molecules of sodium formate water can degenerate, with the elimination of oxygen and the production of caustic soda and sodium acetate. Further, a possible reaction is the combination of the acetate and formate with the reformation of soda carbonate, and the production of acetaldehyde. This new substance is volatile and the rest of it may polymerize into complicated organic compounds, which, acted upon by the free caustic soda, blacken scale formations.

We are all still in the field of intelligent experimentation as to just what is occurring under boiler conditions, but it may be stated with certainty that caustic soda can invariably be found, free oxygen liberated, and at least some formaldehyde produced wherever sodium carbonate exists under a steam pressure greater than 100 lb.

Effect of Caustic Soda Produced by Decomposition of Soda Ash Under Boiler Pressure

With definite evidence then in hand that caustic soda is produced through the decomposition of soda ash, we are now in a position to consider the effect of such caustic soda, and similarly, of course, the effect of caustic soda when added directly as feedwater treatment.

In 1912 a certain boiler distress occurred at the University of Illinois which was investigated by Prof. Samuel W. Parr of that university. The water in question at Urbana, Ill., was unique in character in that it was almost free from sulphates and had from 60 to 70 parts per million of free sodium carbonate. The boiler distress showed first in the form of fine cracks which developed and proceeded either from rivet holes to the surrounding plate, or from rivet hole to rivet hole, or from rivet holes to the edge of the plate where there is no tensile stress whatever. It is interesting to note that these cracks always occurred below the water line and always in conjunction with a leak or other condition, which promoted the concentration of soluble material to the saturation point. The general conclusions arrived at by Professor Parr and his associates were as follows:

1 Caustic soda of sufficient strength attacks iron with the generation of hydrogen.

2 Hydrogen in the nascent state, whether generated by alkali or acid, enters into the texture of the iron in a way to modify its physical properties.

3 The hydrogen effect, at least in its first application, is transient, and after a period of rest or freedom from the hydrogen action, the iron reverts to its normal condition.

4 Sodium carbonate is without action on iron; there is, therefore, no generation of hydrogen. The hydrolysis of sodium carbonate is directly dependent upon the temperature maintained, the withdrawal of the vapor of CO_2, and the admission through the feedwater of carbonated water. It is evident, therefore, that the chemical activity would vary with the ratio of hydrolization or the degree of concentration of the sodium hydroxide.

5 Certain accompanying salts, as the chromates, have an inhibitive effect. Other salts, as sulphates, have at least the effect of acting as diluents. The limits of concentration for maintaining a condition which would be below the danger point have not been studied, but are the features of the case which are of the utmost importance. A continuation of experiments along the lines suggested is in progress.

To say just where the concentration of soda ash and consequently caustic soda becomes dangerous, would be impossible. There are no definite limits which can be placed since the presence of other salts, sulphates and chlorides of sodium, etc., have an inhibitive effect. Consequently larger amounts of soda ash may exist safely in a boiler, in so far as the action on iron is concerned, when the amount of sodium sulphate is larger. The question of excessive soda ash must always be considered in a conjunction with a zeolite softener when the feedwater contains high temporary hardness. It will be recalled that this temporary hardness is converted into sodium carbonate by the action of the zeolite and proceeds to concentrate in the boilers. It is indeed highly advisable that in plants where zeolites are used the concentration of water be tested at frequent intervals and the boilers drained and refilled with fresh water at such times as in the opinion of an expert this should be done. This concentration proceeds differently at different seasons of the year with the fluctuation of the raw water and the varying percentages of condensate and make-up always present in industrial plants from season to season.

In Albany, N. Y., where the author has been checking up an industrial plant on soda concentration, the analysis of the raw water varied from 4.4 to 7.2 grains of lime carbonate per gallon. This was naturally converted to the corresponding sodium carbonate by the action of the zeolites, and on the basis of about 33½ per cent make-up these boilers tested as follows:

Boiler No.	1	2	3	4
Sodium carbonate, parts per million	574	470	483	265

Boilers Nos. 1 and 2 had been refilled with fresh water 12 days previous to these tests, and Nos. 3 and 4 six days previous. In the summer time when all this water will be make-up, the concentration will proceed almost three times as rapidly.

Effect of Cylinder Oil in the Feedwater

There is a definite type of installation in which the returns from engines discharge their drips to the boiler feedwater, and in a number of cases the oil which should be removed by means of separators or other devices has been incompletely taken care of.

On the surface it would seem that the oil entering the feedwater would only be chemically active in so far as its compounding was concerned, and since the average cylinder oil contains between 2 and 8 per cent of organic compounds, it would seem as if only this small percentage of the oil could be saponified since the remaining 90 per cent is of mineral character and in laboratory chemistry is unaffected by soda and unsaponifiable. Here again is the unaccountable to account for. In 1916–1917 the author took occasion to fill a boiler with distilled water to which sufficient caustic soda was added so that 100 cc. of the boiler water required 5 cc. N/10

(Continued on page 660

The Absorption of Gasoline From Casinghead Gas by Activated Charcoal

Particulars Regarding a Series of Tests Undertaken to Evaluate the Process When Applied to a Rich Gas, With Conclusions Drawn Therefrom as to Its Limitations

By H. R. AUERSWALD,[1] TULSA, OKLA.

THE absorption of gasoline from casinghead gas by means of activated charcoal is a comparatively recent method which has received some exploitation. It is in many ways superior to any of the methods at present used in the extraction of gasoline, although its use in connection with gases of different qualities leads to some disadvantages.

In view of the many articles that have appeared in technical publications giving publicity to the process and setting forth its various advantages, tests were conducted by the author at the experimental plant of the Gypsy Oil Company at Drumright, Okla., to investigate the process when applied to a rich casinghead gas, such as is produced in the Drumright District. The results of these tests indicate some rather important conclusions, namely:

1 Charcoal will absorb all the gasoline from casinghead gas at practically atmospheric pressure.

2 It is not possible to distill off and condense all vapors absorbed by the charcoal with superheated steam or by dry heat under the pressures and temperatures ordinarily carried in compression plants.

3 Even if all vapors could be condensed, it is impractical to use the process on casinghead gas of over 2.5 gal. per 1000 cu. ft. yield, if it is necessary to return 65 per cent of the residue gas to the leases for fuel.

4 The results obtained by testing the absorption of casinghead gas by means of activated charcoal and later distilling it in the laboratory with glycerine will give less yield than the gross or net yield obtained from the usual physical testing equipment in the field.

5 The investigation has not been carried to a point where it would be able to state whether or not the scheme would be more economical than mineral-seal-oil absorption on a low-pressure gas (about 20 lb. per gal.) of low yield. The mineral-seal-oil plant would be more economical from the view point of fuel gas consumed. However, if the charcoal does not deteriorate the cost of new absorbent would be less than in an oil-absorption plant.

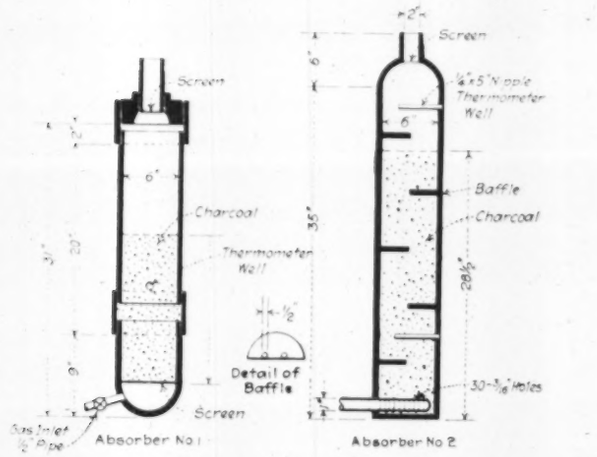

FIG. 1 DETAILS OF ABSORBERS CHARGED WITH ACTIVATED CHARCOAL.

DETAILS OF APPARATUS USED IN TESTS

In these tests two absorbers of special design which provided entrance for casinghead gas, residual gas, and superheated steam were utilized. The details of these absorbers when charged with charcoal and the general arrangement of the other equipment are shown in Figs. 1 and 2, respectively.

As shown in Fig. 2, casinghead gas can be metered to the absorber G or to the compressor C through the meter M. With this arrangement a physical test of the gas may be made by metering the gas before it enters the compressor. In this case the residual gas is allowed to escape at X, while the gasoline condensed is drawn off from the accumulators A and B at D and E. An absorption test with charcoal can be made by metering the gas, passing it thence through pipe F to the bottom of the absorber G. In this latter case the residual gas may be drawn from the top of the absorber G, thence to the compressor C, and by compressing the gas to a suitable pressure it can be determined what degree of gasoline absorption the charcoal effects.

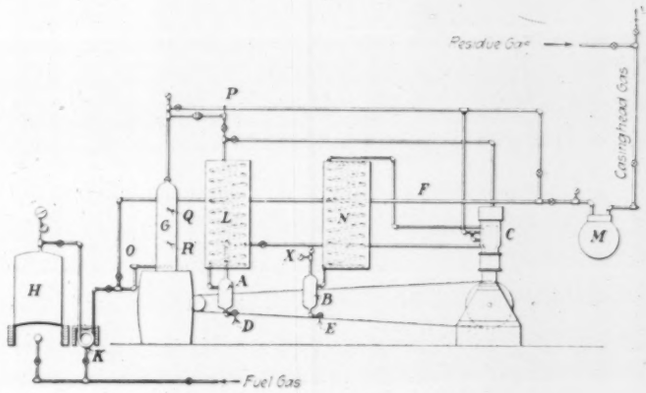

FIG. 2 GENERAL ARRANGEMENT OF THE APPARATUS USED IN TESTS TO DETERMINE GASOLINE IN CASINGHEAD GAS BY CHARCOAL ABSORPTION

After the charcoal has absorbed the gasoline, superheated steam can be admitted to the absorber G from the boiler H and the superheater K. The steam and gasoline vapors are then condensed in the condenser L, while any uncondensed gasoline vapors may be transferred to the compressor C, there compressed to any desired pressure, later cooled and condensed in the condenser N, and finally collected in the accumulator B.

RESULTS OF TESTS

The results of the several tests made with this equipment utilizing the two different absorbers, and under various conditions, are shown in Table 1. From the study of these results the following interesting observations may be made:

1 Test No. 5 shows that the charcoal will absorb 22.5 per cent of its volume and 25.3 per cent of its weight in gasoline if the gas is passed through at the correct velocity. Test No. 2 showed that when the charcoal had been saturated to 15.8 per cent by volume the gasoline began to come through.

2 The best absorption seemed to be effected by a slow speed through the absorber. For the quality of the gas tested the best rate seemed to be from 9 to 12 ft. per min. through the absorber. As the charcoal was 36 per cent voids, this would be a velocity of 25 to 33 ft. per min. through the charcoal.

3 Line 10 of Table 1 shows that in each test, gasoline was condensed from the residue gas by compression. It should be realized, however, that this may have been caused by too high a velocity of the gas or by oversaturation of the charcoal. The charcoal will absorb all the gasoline from the gas if it is not oversaturated and if the gas is allowed to pass through at a slow enough velocity.

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Presented at a joint meeting of the Mid-Continent Section of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, and local sections of the American Chemical Society, A.S.C.E., A.I.M.E., A.I.E.E. and A.A.E., at Tulsa, Okla., April 28-29, 1921.

4 Line 14 shows that in tests Nos. 2 and 4 the temperature of the charcoal was raised to a point which would be difficult to maintain in practice. This temperature apparently distills all of the gasoline from the charcoal so far as a flame test on the charcoal afterward will show, but the gasoline vapor formed is of such a volatile nature as to prevent condensation. In all tests except No. 2 the vapors which were uncondensed in accumulator A were compressed to 250 lb. gage pressure, and cooled, but they still remained uncondensed.

5 Line 16 gives in percentage the quantity of gasoline condensed by distillation of the charcoal as compared with the gross yield of the gas by physical test. Line 17 shows comparison of the yield by absorption and distillation from charcoal with that obtained when the gross product as made by physical test is weathered to 60 deg. fahr. and "net" yield is thereby obtained.

TABLE 1 RESULTS OBTAINED IN TESTS WITH TWO DIFFERENT TYPES OF ABSORBERS

1	Absorber No.	1	1	1	2	2
2	Test No.	1	2	3	4	5
3	Date	12/16/20	12/20/20	12/23/20	12/29/20	1/5/21
4	Volume of gas run through absorber, cu. ft.	40	80	112	150	180
5	Volume of charcoal in absorber, cc.	7330	7330	7330	13250	13250
6	Weight of charcoal in absorber, cc.	9.17	9.17	9.17	16.55	16.55
7	Gross gasoline contents of gas as determined by physical test, cc. per cu. ft.	17.70	17.70	11.60	20.00	16.90
8	Gasoline contents of gas gross, gal. per 1000 cu. ft.	4.675	4.675	3.070	5.320	4.47
9	Total gross gasoline in gas passed through absorbers, cc.	708	1420	1300	3018	3050
10	Gasoline condensed in residue gas by compression during test, cc.	144	40	78	337	58
11	Total gasoline absorbed in charcoal, cc.	564	1380	1222	2681	2992
12	Efficiency of charcoal as absorbent at the rate which gas was passed, per cent	79.6	97.00	94.20	89.00	98.20
13	Maximum steam temp. passed into absorber, deg. fahr.	600	820	.....	820	720
14	Maximum temp. of charcoal during distillation deg. fahr.	350	660	400	720	570
15	Total gasoline driven off and condensed, cc.	216	455	572	1024	877
16	Efficiency of the distillation from charcoal compared with gross yield by physical test, per cent	38.3	33.0	46.7	38.0	28.3
17	Efficiency of the distillation from charcoal compared with net yield of physical test, per cent	.....	.....	75.5	54.4	47.8
18	Water condensed during test, cc	13250	7100	12300	32100	19800
19	Ratio of water condensed to gasoline produced	61:1	15.7:1	21.5:1	32:1	22.6:1
20	Rate of passage of gas through absorber, cu. ft. per min.	5	1.45	2	2.35	1.7

The pressure on the absorber during all absorption tests while the gas was passing through was 4 oz.

In some of the tests the steam pressure on the absorber was raised to 50 or 60 lb. during the distillation.

After tests Nos. 1 and 2 the charcoal was taken out of the absorber and a sample tested with a flame to ascertain whether or not gasoline still remained in it. No evidence was found of the presence of gasoline and the charcoal was perfectly dry and dusty.

6 Line 19 shows that a large quantity of steam must be condensed to produce a small quantity of gasoline. All of the ratios in the column are perhaps high on account of the fact that in all tests steam was introduced for a long period of time to obtain a high temperature in the charcoal. From observations made on test No. 2 it seems that the steam which would have to be forced through the charcoal under ideal conditions so as to distill the gasoline would be 7 parts of water to 1 part of gasoline by volume. It would be necessary under those conditions to generate superheated steam from 7 gal. of water for each gallon of gasoline made.

To generate a pound of steam at 35 lb. boiler pressure and heat it to 600 deg. fahr. requires 1144 B.t.u. Assuming a boiler efficiency of 70 per cent and fuel gas of 1000 B.t.u. per cu. ft., it would require 95 cu. ft. of fuel gas per gallon of gasoline produced.

Because of this large consumption of residue gas it is evident that the method would be impractical on casinghead gas of this quality, especially if residue gas is to be returned to the leases. The residue gas per 1000 cu. ft. would be only about 766 cu. ft., 445 cu. ft. of which would be burned at the gasoline plant, leaving only 321 cu. ft. to be returned to the leases or 32.1 per cent of the original volume delivered. A compression plant handling the same gas efficiently would consume only 90 cu. ft. of the residue gas, leaving 676 cu. ft. for return to the residue system or 67.6 per cent of the original volume.

The consumption of fuel gas would not be such a great objection, however, if the method were used on low-pressure gas of low gasoline content. The gas consumed for fuel, however, would be more than that consumed by an absorption plant of the absorbing oil type,

TABLE 2 DISTILLATION TEST OF GASOLINE

(Product used, 70 deg. B.)

Per cent Off	Temp., deg. fahr.	Per cent Off	Temp., deg. fahr.
I.B.P.	98		
20	140	60	212
20	163	70	220
30	176	80	249
40	189	90	285
50	200	95	318 (End Point)

(Recondensed in flask, 1 per cent; loss 4 per cent; gravity of condensate, 68 deg. B.)

for in the charcoal process the latent heat of the steam is totally lost, whereas in a plant where mineral seal oil is used the latent heat is utilized in evaporating the gasoline.

7 All the gasoline absorbed in the charcoal was not recovered in any of the tests, but in all tests the gasoline recovered was distilled off before the temperature in the charcoal was raised to 400 deg. fahr. Perhaps a higher temperature than this is needed to

TABLE 3 RESULTS OF DRY DISTILLATION TESTS

Test No.	1	2	3	4	5	6
Charcoal in flask, cc.	1000	1000	1000	1000	1000	1000
Gasoline poured on charcoal, cc.	200	200	200	200	200	200
Gravity of gasoline, deg. B.	66.5	65.5	71.4	70.4	70.5	70.3
Max. temp. to which charcoal was raised, deg. fahr.	830	816	740	770	735	730
Max. temp. of vapors, deg. fahr.	326	358	440	380	418	370
Gasoline recovered in condenser, cc.	113	180	172	200	178	168
Assumed loss, cc.	8	8	8	8	8	8
Gasoline distilled from charcoal, cc.	121	188	180	208	186	176
Percentage of original gasoline recovered	60.5	94	90	104	93	88
Percentage of accumulated condensate to original sample	60.5	77.2	81.5	87.0	88.3	88.2
Gravity of condensate from the test, deg. B.	70	68.2	69	67.5	68.4	63

Total gasoline put on charcoal during six tests ..... 1200 cc.
Total gasoline recovered from six tests ..... 1059 cc.
Per cent of total recovered 88.2

reactivate the charcoal, but it is not needed to distill off the gasoline. The exact temperature required could be determined only after a long series of tests.

After the distillation of the gasoline in test No. 5, residue gas was passed through the charcoal and the same cooled down. When the residue gas was passed through the absorber the temperature of the charcoal was 535 deg. fahr. and the absorber temperature

TABLE 4 DISTILLATION TEST OF GASOLINE

(Glycerine poured over the charcoal)

Per cent Off	Temp., deg. fahr.	Per cent Off	Temp., deg. fahr.
I.B.P.	130		
10	170	60	206
20	188	70	238
30	190	75	280
40	196	82	294
50	200	89	350

(Gravity of condensate 69.7 deg. B.)

just above the charcoal was 435 deg. fahr. Residue gas of 67 deg. fahr. temperature was passed through the absorber for 2⅓ hours at rates varying from 2 to 3 cu. ft. per min. After 360 cu. ft. of gas had been passed through the charcoal the temperature was still 111 deg. fahr. and the absorber temperature above the charcoal was 165 deg.

Inasmuch as there had been only 180 cu. ft. of green gas originally passed through the absorber, this test indicated that the absorber would have to be cooled by some other method in addition to residue gas, or the residue gas would have to be recirculated by pumps through the absorber and cooling coils two or three times in order to properly cool the charcoal.

(Continued on page 606)

Efficient Operation of Oil-Burning Steam Plants

A Discussion of the Plant Characteristic Diagram, with Particulars Regarding Its Use in the Establishment of a Standard of Performance and in Increasing Plant Efficiency

By C. H. DELANY,[1] SAN FRANCISCO, CAL.

DURING the past ten years there has been a remarkable increase in the efficiency of steam plants, both oil-burning and coal-burning. Ten years ago there were many plants operating reciprocating engines, in which the maximum economy obtained was not over 150 kw-hr. per bbl. of oil.

With the high-pressure steam-turbine plants of the present day a record of 330 kw-hr. per bbl. has been made. This increase in efficiency has been brought about by introducing more efficient machinery and increasing the range of steam pressure in the prime mover. The introduction of the steam turbine to replace the reciprocating engine effected a remarkable saving in the quantity of fuel required. Moreover the steam turbine caused a saving in operation due to the fact that its operation does not depend on the personal element in the plant.

In the old reciprocating engines there were many adjustments to be made by the engineer in charge, and the economy obtained depended very largely on the skill of the operating engineer and the care with which he made the various adjustments. With the steam turbine, however, there is nothing that the operator can do to improve the efficiency after the machine is once installed and placed in good operating condition. While this is true as regards the prime mover, it is not true in regard to many other features of the power plant. In the boiler room particularly there are many points where the operating engineer can effect a saving if he carefully studies the situation and pays attention to the small details of operation. In condensers and vacuum pumps also a great saving can be made if proper attention is paid to maintaining a high vacuum. There is still, therefore, a large field for the operating engineer in improving the economical operation of the plant, and the question of operating efficiency is consequently one worthy of very careful study.

Many tests have been published showing very high efficiency of boilers where fired with fuel oil, efficiencies as high as 80 and 82 per cent being not uncommon in test reports. It is very rare, however, that any such high efficiencies are obtained in the regular operation of power plants. In order to maintain high efficiency in regular operation of a plant, the first requisite is some means of comparing one day's operation with another. In oil-burning electric power plants it is customary to report the economical operation of the plant in terms of kilowatt-hours generated per barrel of oil. This is an excellent method of comparing one day's operation with another, provided there is steady load on the plant and conditions remain the same from day to day. With a variable load, however, such as occurs in an ordinary central-station plant, it is always found that the economy is much better at periods of heavy load, and poorer at periods of light load. Thus it is possible with a fairly heavy load on the plant to secure from 220 to 230 kw-hr. per bbl. of oil without difficulty, whereas with the same plant operating at a light load it may be difficult to secure more than 150 kw-hr. per bbl. of oil.

When the good results are obtained with the heavy load, the operating men pat themselves on the back and consider that they are doing fine, because results are better than the average. On the days of light load when the results are poor, they do not worry but say, "What's the use, you can't expect any results with such a light load." Thus in neither case is there any incentive to improve the economical operation of the station. Another reason for more or less lax methods, so far as efficiency is concerned, is the fact that efficiency must always be secondary to continuity of service. The men at the plant know that any interruption to service will be a matter of close investigation on the part of the management, and they devote all of their energies to maintaining the plant in operation and keeping the lights burning. For instance, if a fireman in endeavoring to carefully adjust the air supply in his boilers neglects to keep up the steam pressure, with the result that the turbine slows down and some of the load has to be dumped, he is sure to be called on for an explanation. If on the other hand he keeps up the steam pressure, but neglects to regulate the air in the proper proportion, there usually will be no complaint; and the boilers may be allowed to operate in this inefficient manner for a considerable length of time. The author is far from disputing the fact that continuity of service is a matter of prime importance, but he does wish to point out that efficiency is a close second. The problem before us, therefore, is to so interest the men who are operating the plants in the matter of efficiency that they will not neglect the various operating details that must have attention in order to secure good results.

In order to improve these conditions and to interest the men in the problem of efficiency, it is essential to devise some means of comparing the performance of a plant from day to day. For this purpose, the diagram here called the "plant characteristic diagram" has been plotted.

The Plant Characteristic Diagram for Comparing Performances from Day to Day

Fig. 1 shows such a diagram for one of the San Francisco stations. It consists merely in the plotting of the oil consumption against the kilowatt-hours generated. Each of the points in this diagram represents one full day's operation, and while the points as shown are more or less scattered, it is apparent that they form a well-defined line. It is thus possible to draw a straight line through the midst of these points in such a way that it will represent the average location of all the points in the diagram. There is nothing new in the use of a straight-line diagram, such as is presented. The line is similar to the Willans line for steam engines, where for throttling engines the total steam consumption plotted against the horsepower output is always found to be a straight line. A similar line for steam turbines is either straight, or very nearly so, depending on the design of the turbine. The use of the Willans line in the design of steam power plants was very ably described by R. J. S. Pigott in a paper read before the A.S.M.E. in 1916.[1] The use of the plant characteristic diagram in improving the efficiency of steam plants has been described very fully by Robert H. Parsons[2] of London; and in fact in describing this system as applying to oil-burning plants, the author is simply amplifying Mr. Parsons' paper on the subject.

Use of Diagram as a Standard for Guidance of Men in Operation of Plant

The diagonal line, having once been drawn through the points as described, may be used as a standard for the guidance of the men in future operation of the plant. Thus each day the kilowatt-hours generated and the oil burned the day before may be plotted on this diagram. If the point so plotted is found to fall below the diagonal line, it is evident that the results obtained are better than the standard. If the point falls above the line, too much oil has been used, and there is something wrong requiring a special investigation; and since the diagram takes in all loads from zero up to the full load on the plant, it is evident that it allows for the poor economy obtained at light loads. It is thus possible for the operating men to know immediately whether they are keeping up to the required standards of efficiency or running behind. They are therefore able to investigate causes of low efficiency immediately while all matters entering into the plant operation are fresh in their minds.

In adopting the standard it would be possible, instead of drawing a line through the average of the points, to draw a line through

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[1] Pacific Gas & Electric Co. Mem. Am.Soc.M.E.

Paper presented at a joint meeting of the San Francisco Sections of The American Society of Mechanical Engineers and the American Institute of Electrical Engineers, March 17, 1921. Slightly abridged.

[1] Trans. Am.Soc.M.E., vol. 38, p. 687.

[2] *Electrical Review* (Chicago), Feb. 21, 1920, p. 311.

the best points, thus establishing a standard that would represent the best results obtainable from the plant. Again, it would be possible to establish a standard by drawing a theoretical line below all of the points, this line to be based on the steam consumption of the turbines and auxiliaries, as determined by tests, a boiler efficiency of, say, 80 per cent and the best possible vacuum. In other words, a line representing ideal conditions.

In adopting the average line as the standard it is felt that the men will have greater confidence in the method than if a theoretical line had been adopted. The average line is really a standard that

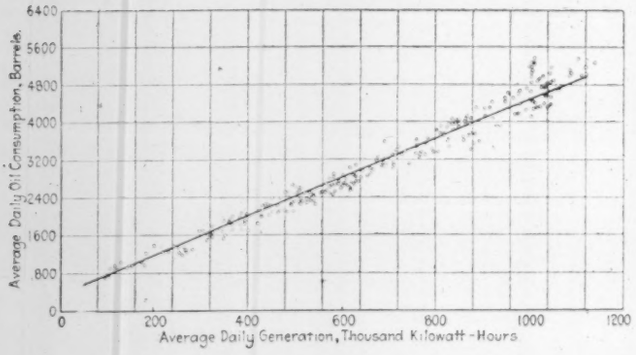


FIG. 1 PLANT CHARACTERISTIC DIAGRAM FOR A SAN FRANCISCO STATION

has been established by the men themselves. It is not an arbitrary ideal impossible to attain, but as it represents the average already attained, it should be as easy to improve on the results represented by the line as to fall below them.

If the men are successful in improving on the standard each day, it is obvious that the average for a given year will represent better efficiency than the average for the previous year. With all of the points falling below the line on the diagram, another line drawn through the average of these new points would also fall below the original line.

A diagram with the same diagonal line as determined by Fig. 1, but with the points omitted, may be used at the stations each day to plot the results of the day before.

Figure 2 shows a similar diagram, but with the scale altered so as to show the kilowatt-hours generated and the oil burned during a period of 8 hours instead of 24 hours. This diagram may be used by the different shifts in the station so that each shift can check up its own performance and compare it with the performance of the other shifts. A large diagram of this form is posted on the wall of the fire room, and different colored pins to represent the different shifts are inserted each day so that the diagram shows at all times which shift is running above the line and which shift is running below it. This system has a far-reaching effect in awakening interest in the men, and leads to rivalry and competition so that they are extremely anxious to improve the efficiency, and the laxity which previously existed in regard to efficiency is disappearing. As the diagram allows for variations in load, it is possible to compare the day shift when the load is heavy with the early morning shift when there is very little load on the plant, thus making a fair comparison which was never possible with the old method of merely figuring the kilowatt-hours per barrel of oil.

OPERATING EFFICIENCY AND ITS DETERMINATION

There is one objection to the diagram—it does not indicate the order in which the records are plotted, and therefore does not show whether the results are improving as time goes on. In order to overcome this objection, and also to enable the operation of different plants to be compared with each other, the term "operating efficiency" has been introduced. Operating efficiency as used in this connection means the percentage of standard attained for the day's run. "Operating efficiency" is entirely distinct from "boiler efficiency" or "turbine efficiency" or "thermal efficiency" or "Rankine-cycle efficiency." All of these enter into the operation of the plant in determining the standard. Operating efficiency is merely a comparison of the results actually obtained with the standard.

The method of determining operating efficiency can best be shown by an example: During one eight-hour shift there were generated 313,000 kw-hr. and 1440 bbl. of oil were burned, representing an economy of 217 kw-hr. per bbl. From the diagram it is found that for a load of 313,000 kw-hr. with standard efficiency, there would be burned only 1400 bbl. of oil, which would be equivalent to 224 kw-hr. per bbl., as against the actual result obtained of 217 kw-hr. per bbl. The operating efficiency is therefore 217 divided by 224 or 97 per cent. During another eight-hour shift, where there were only 25,000 kw-hr. generated, the oil burned was 200 bbl., equivalent to 125 kw-hr. per bbl. From the diagram it is found that for 25,000 kw-hr. with standard efficiency the oil burned would be 220 bbl., equivalent to 114 kw-hr. per bbl. The operating efficiency is therefore 125 divided by 114 or 110 per cent. It is thus seen that although in the second case there were only 125 kw-hr. per bbl. obtained, as against 217 in the first, the operating efficiency was actually higher in the second case than in the first.

It is evident from the foregoing that if an operating efficiency of 100 per cent is obtained, it means that the economy of the plant is the same as the average of last year, since last year's records were used to establish the standard. If more than 100 per cent operating efficiency is obtained, the results are better than last year, and if less than 100 per cent is obtained, they are worse. It is obvious that this method of determining operating efficiency makes allowance for inefficient machinery, and it is just as easy to obtain 100 per cent operating efficiency in a plant having old-fashioned turbines of poor design as in a plant having the most up-to-date machines, for the standard is based on the actual records of the plant in question.

Fig. 3 shows the operating efficiency of one of the plants plotted for each day during the months of January and February. In this diagram the horizontal line at 100 per cent represents the standard efficiency and the zigzag line the actual operating efficiency obtained each day. The records show a gradual improvement in the operating efficiency during the period, which is a direct result of the attention to small details brought about by this method of checking up efficiency.

In addition to the use of the diagram for setting standards and creating interest among the men, a system of weekly and monthly reports and bulletins has been adopted. The weekly report, which is made out by the efficiency man at each station, gives the operating efficiency for each day and the average for the week, and in addition a brief statement of some of the more important instrument readings such as flue-gas analysis, vacuum, feedwater temperature, and steam consumption of turbines at different loads. The monthly report which is made out at the office and sent to

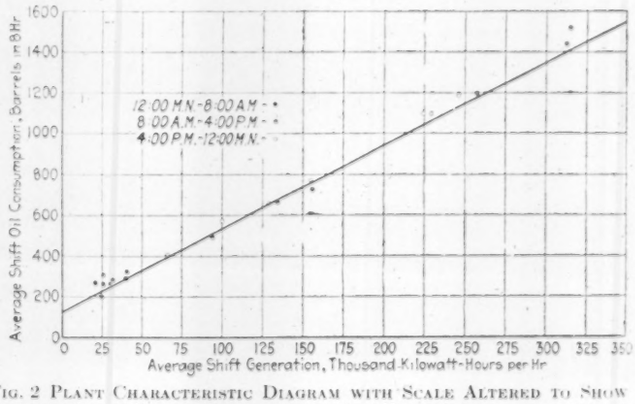


FIG. 2 PLANT CHARACTERISTIC DIAGRAM WITH SCALE ALTERED TO SHOW RESULTS OBTAINED ON AN 8-HOUR SHIFT

each station includes a diagram of operating efficiency similar to Fig. 3 for all stations plotted on one sheet, together with a brief statement of comparative results obtained and suggestions for improved methods. A liberal use is made in the stations of flow-meters and other instruments that serve as a guide to the firemen in the proper regulation of their fires.

Since the diagonal line in the plant characteristic diagram is usually a straight line, it can of course be represented by a simple equation, namely:

$$y = a + bx$$

where y is the oil consumption in a given period in barrels or pounds, x the kilowatt-hours generated in the same period, and a and b are constants.

Evidently the constant a is equal to y when $x=0$, or in other words a represents the quantity of oil burned for zero load; that is, the amount required to keep up steam on the boilers, keep the turbine running up to speed, operate the vacuum pumps, circulating pumps and other auxiliaries, and keep the entire plant in readiness to take on load at a moment's notice. Obviously a will be larger if two turbines with their auxiliaries are kept in operation than only one, so that its value depends on the amount of load the plant is expected to take on. Where a plant is operated as a standby to a hydroelectric system and is kept in readiness to instantly pick up its full load in case of trouble, a will have a higher value than where it is possible to gradually shut down the turbines one after the other as the load falls. The constant b evidently represents the additional amount of oil burned in proportion to the load carried on the plant. It determines the slope of the line in the diagram, and is large for uneconomical turbines or engines and small for the most efficient types. The equation of the line in Fig. 2 in terms of barrels of oil and kilowatt-hours for an eight-hour shift is—

$$y = 120 + 0.0041\,x$$

Other Uses of the Plant Characteristic Diagram

The characteristic diagram may be used for many other purposes besides the overall efficiency of the plant. By plotting the steam generated against the oil burned in one diagram, and the steam consumption against the kilowatt-hours generated in another, it is possible to study the boiler-room and engine-room operations separately, and thus quickly locate the cause of low efficiency. By setting separate standards for the boiler-room and engine-room crews, responsibility can be more definitely fixed and the advantages of the system of operation greatly enhanced.

Since boiler efficiency usually decreases quite rapidly as the capacity increases above the boiler's rating, a single boiler will naturally have a curved characteristic. In a plant containing a large number of boilers, however, the boiler-room characteristic will be approximately straight until the load exceeds the economical capacity of all the boilers in the plant, after which it will begin to curve upward. A curved line, based on previous performance, is just as satisfactory as a straight line for setting standards and calculating operating efficiency in the manner described. Fig. 4 shows the power used by electric auxiliaries in a station, plotted against the total generation, and is of interest in showing that the points do form well-defined straight lines, and that the same methods may be used for standardizing these items as for fuel consumption and steam consumption.

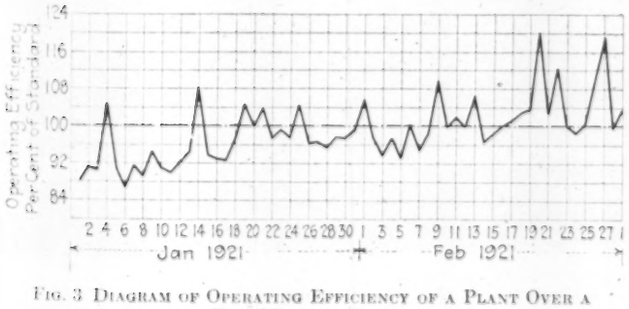


Fig. 3 Diagram of Operating Efficiency of a Plant Over a Two-Months' Period

To sum up, the essentials for securing the best efficiency in power-plant operation are:

1 A fair standard by which the daily performance can be measured and compared with previous results, at the same time giving the operating men a definite goal to work to.

2 Means of comparing results obtained by different groups of men, such as different shifts of one plant or the crews of different plants, and the posting of this comparison so that the men can see the results of their efforts

3 A system of reports that keeps up the interest of the men. combined with suggestions and advice that show where losses occur and how they may be avoided.

If the operating men are kept interested, see the results of their work, and have a definite standard to reach, they will do their best. As interest flags some sort of bonus or prize for the crew showing

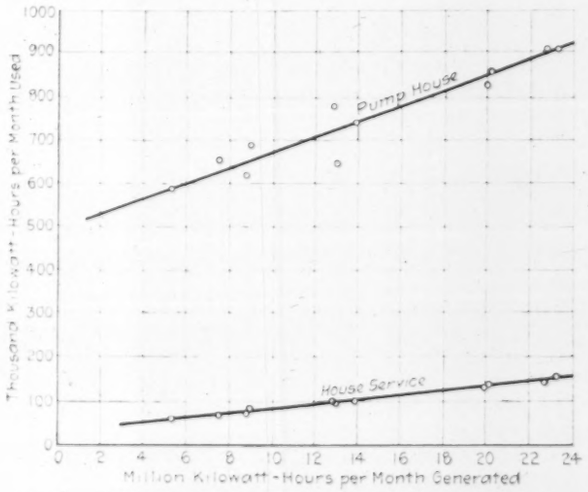


Fig. 4 Power Used by Electric Auxiliaries in a Station, Plotted Against the Total Generation

the best operating efficiency will stimulate them to greater effort, and by guiding this effort by means of thoughtful analysis of the technical features of the power plant, maximum efficiency may be obtained.

The Trent process of cleaning coal, developed on a result of certain suggestions made during the war by Walter E. Trent to the War Inventions Board, consists in agitating together powdered coal, water and oil. This produces a partly de-ashed plastic fuel, called an "amalgam," the oil selecting the coal particles and largely excluding the water and ash. The amalgam can be freed from water mechanically held by working, much as butter is.

This amalgam can be burned in several ways; for example, it may be shoveled or forced through pipes by pressure; it can also be stored under water if desired.

For pulverizing fuel, wet grinding presents many advantages over dry grinding, provided the water can be eliminated afterward.

To be able to reduce the ash in coal may make available great quantities of low-grade coals and material now considered as waste at the mines.

If an oil is used that can be distilled at a temperature below the distilling temperature of the coal, powdered fuel is reclaimed from the amalgam and the oil may be reused. If a heavy oil be used and distilled to dryness, a coke product may be recovered, although the coal may have had no coking quality. If the distillation proceed only to a heavy pitch, a mass suitable for briquetting may be made.

In distilling oil mixed with a finely powdered material the distillates are similar to those obtained by distilling under pressure so that the distillation of an amalgam of coal and oil gives quantities often more favorable than the sum of the separate distillations of the coal and the oil.

The amalgam can be used for a gas-making fuel, and gas-house-tar emulsions can be dehydrated by mixing with powdered coal, the amalgam being retorted for further gas making.

Graphite ore can be separated from its gangue, and coke can be separated from flue dust by using the Trent Process. Clean coal in anthracite sludge will make an amalgam if oil is added.

This brief sketch of possibilities revealed by small-scale laboratory work shows that the field for investigation and development is large. The general results show that real benefits are physically possible by treating coal in this manner.—From an article by O. P. Hood, Chief Mechanical Engineer, U. S. Bureau of Mines, in *Power*, Aug. 2, 1921, p. 196.

DIE SINKING AND METAL PATTERN-MAKING BY AUTOMATIC MACHINE

(Continued from page 588)

unusual layout which could not have been accomplished in the old way.

There is another very important point which must appeal powerfully to the thoughtful engineer: A mechanical method which makes of die reproduction merely a routine manufacturing proposition insures constant use and employment of correct dies; the necessity for keeping or the temptation to keep in use dies that have sunk, checked, or spread, is removed. The resultant decrease of rejections and scrap, with a consequent saving of labor and material, is quite evident. What this means to the growth of an industry may be left to the imagination.

Fig. 14 shows a roll-cutting machine. This is a three-dimension automatic machine which cuts a pattern intaglio or relief on the periphery or the inside of cylindrical surfaces. It is useful on embossing and forging rolls for rubber, metal, lace paper, male and female, and particularly for cutting molds for glass.

The propeller-carving machine shown in Fig. 15 is obviously not a die-cutting machine, but is of interest because it shows a very useful application of the principle of the duplicator. This is a very productive machine and capable of cutting accurate and true propellers of any desired shape of pitch. It has records to its credit of 50 large propellers in 8 1/2 hours out of the fullg-lued blank, cutting down to size, ready for sanding.

Fig. 16 shows another interesting applic tion of the reducing machine, designed to overcome the difficulty of getting a smooth and uniform bucket on the wheels of the steam turbines used in connection with torpedoes. The principle is the same as that previously described in connection with the reducing machine for cutting ellipses, with the addition of a special automatic indexing mechanism which carries the turbine wheel and a templet or model the exact shape of the outer contour of the bucket, but four times its size. Spiral end mills and a roller tracer are used.

It has been many times reiterated that without the munitions produced by the American industries, including the machinery, tools, and the great quantities of articles that were so essential, the late war could not have been successfully carried on.

In this connection it may be said that automatic die-sinking machines not only produced many thousands of dies in this country but were also used in the British, French and Italian armories and artillery plants. They supplied dies for howitzers and field guns, for turbines and other parts of torpedoes, for Liberty motor parts, saddlery, shells, surgical instruments, bayonets, trench tools, hand grenades, Emergency Fleet and other marine forgings, aircraft telephone reels, navy chains, submarine parts, horseshoes and tractors.

The question naturally presents itself, how could all these thousands and thousands of dies have been produced had man power been the sole source of supply?

UTILIZATION OF LOW-GRADE COTTON

(Continued from page 596)

body, wiry, of good staple and possesses excellent spinning qualities, permitting the use of less twist and the securing of a higher production. The cleaning machine produces the most remarkable results in cleaning all these types of cotton and makes it possible for a mill to use such cotton in producing many kinds of goods.

On a unit of twenty machines in commercial cotton cleaning where the cotton is rebaled, the cost is less than 1 cent per lb., taking everything into consideration except the shrinkage in stock. This unit of machinery will clean about two bales per hour. In 1920 the profit was from 5 to 7½ cents per lb., and at present the author believes it to be from $20 to $25 per bale.

In a manufacturing plant cotton could be taken to the cleaning outfit, opened, cleaned and blown into the picking department. In order to mix this stock properly a mechanical mixer should be used. To reclaim card strips or comber noil the cleaning machine should be installed in the picker room. As the strips are taken from the card, they can be run through the machine and mixed with the cotton in such a percentage as is necessary in number up to and including 40s and then forgotten.

Our machine builders now make equipment to manufacture any kind of product required. What is known as the "coiler" system is used on hard yarns and is perfected to spin good yarn from very low stock. The greatest difficulty has been overcome by being able to clean this stock properly and to mix it in absolutely uniform batches. Most of this low-grade product, especially in Europe, was manufactured on what is known as "woolen machinery." The Europeans were successful because of their low-priced labor and the great care taken with cleaning and mixing. We have learned this and with our improved machinery are in a position to take any raw product and utilize it as efficiently as they.

WATER TREATMENT FOR BOILERS

(Continued from page 600)

normal sulphuric to neutralize it. The cylinder oil analyzed as follows:

Flash point	520 deg. fahr.
Fire test	590 deg. fahr.
Gravity at 60 deg. fahr.	25.7 deg. B.
Viscosity at 210 deg. fahr. (Saybolt)	120 sec.
Fat (as tallow)	5.2 per cent
Free acid (as oleic acid)	0.12 per cent

One quart of this oil was injected into the boiler, which was operated at 125 lb. pressure. At the end of three days the water was just faintly alkaline to phenolphthalein, although there was theoretically nothing in that water which should have absorbed the alkali.

THE ABSORPTION OF GASOLINE FROM CASINGHEAD GAS

(Continued from page 602)

After three tests in which steam had been used for distillation, it was demonstrated that all the gasoline could not be distilled and condensed by this method. It was then decided to investigate distillation by dry heat.

The apparatus used in this test was a standard 1000-cc. distillation flask and copper condenser. The distillations were conducted as follows: 1000 cc. of charcoal was placed in the flask and 200 cc. of low-gravity gasoline poured over it. The gasoline used was a drip product of 70 deg. B., with an initial boiling point of 98 deg. fahr. The distillation test of Table 2 shows that it was a very stable product which could be distilled and condensed at atmospheric pressure without excessive loss.

Table 3 shows the results obtained when dry distillations were made by saturating 1000 cc. of the charcoal with 200 cc. of the gasoline under consideration.

The same charcoal was utilized in all tests, but after each distillation the charcoal was cooled down to roora temperature before another charge of gasoline was tested.

From Table 3 it is to be noted that in the distillation of gasoline from charcoal by dry heat a greater loss is encountered than when the gasoline is distilled alone. The contact of the gasoline with the charcoal seems to render a certain part of the vapor more volatile. Thus, the use of charcoal for testing casinghead gas, if distilled dry, would give an incorrect yield when compared to the gross or net yeild obtained by the use of a compression physical testing equipment.

A test was conducted to determine whether or not all of the gasoline contained in a certain sample of charcoal could be distilled off and condensed if glycerine is poured over the charcoal containing the gasoline.

A 500-cc. distillat on flask was set up and 250 cc. of charcoal placed in it. 100 cc. of gasoline of low gravity was then poured over the charcoal, after which 150 cc. of glycerine was added. Gasoline of 71 deg. B. was used which had a 4 per cent loss in its own fractional distillation.

Inasmuch as the boiling point of the glycerine with charcoal is 350 deg. fahr. the test was stopped at that point.

Results of this test indicate, as shown in Table 4, that even in the presence of glycerine it is not possible to distill off and condense the original quantity of gasoline in the charcoal without an unusually high distillation loss. In this particular case the results obtained show an unaccounted-for loss to the extent of 7 per cent.

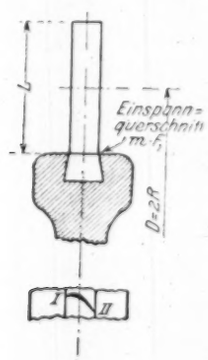
SURVEY OF ENGINEERING PROGRESS

A Review of Attainment in Mechanical Engineering and Related Fields

Steam Turbines for Maximum Loads

By A. LOSCHGE

THE author believes that the development period of the steam turbine, which has been extremely rapid and at times precipitate, is about over. Out of a plethora of inventions only a few types of construction have survived and these have been adopted by practically all turbine builders and are very nearly the same everywhere, notwithstanding material differences in design and construction of metals. These types represent mainly combined turbines with high- and low-pressure stages and for a number of years turbine designers have endeavored to improve and simplify these combined turbines, their efforts being mainly directed toward increase of speed and reduction in the number of stages. As the result of this, it has become possible to employ a speed of 3000 r.p.m., which is the highest that can be used to drive a 50-cycle alternator, and has been applied to increasingly large units of output. How well turbine designers have succeeded in this direction is shown by the fact that the maximum output, that is, the output which can be secured from a turbine unit at the maximum speed of 3000 r.p.m., has increased from 6000 hp. in 1912 to 8000 in 1914, and to about 25,000 in 1921. It is clear that this tendency has very great economic importance and that from now on all turbine builders will have to construct maximum-output turbines.



FIGS. 1 AND 2 TURBINE BLADES
(*Einspannquerschnitt* = Cross-Section at Fastening.)

From this the author proceeds to a discussion of the magnitudes which determine the value of maximum output of a turbine, the technical difficulties which have to be overcome in order to make a higher output possible, and finally the ways and means adopted by various concerns to overcome these difficulties. Because of lack of space only certain parts of the articles can be here abstracted.

Importance of Blade Length in the Last Turbine Stage. The magnitude of maximum output of a turbine is in the first place determined by the length of the blades in the last turbine stage and there are certain conditions which determine the maximum possible length of the longest blade at each circumferential speed u. It was found at the start that the ratio—

$$\frac{\text{average diameter of wheel } D}{\text{blade length } L}$$

should not be less than 5 in the utmost case, since otherwise the blade passage becomes too wide on the outside and too narrow on the inside, which causes a very uneconomic utilization of the steam. From this limiting value $D/L = 5$ it appears that for constructive reasons for a given speed of rotation n the values for L for any circumferential speed u should not exceed those given in the following table:

u (meters per second)	100	125	150	175	200	225	250
D (meters)	0.637	0.796	0.956	1.114	1.274	1.433	1.592
L_{maxI} (at $D/L_{maxI} = 5$) meters	0.127	0.159	0.191	0.223	0.255	0.287	0.318

The blade length L_{maxI} is computed from the equation

$$L_{maxI} = {}^1/_5 D = {}^1/_5 u/(\pi n/60) = {}^1/_5 u/(\omega/2) \quad \ldots\ldots\ldots\ldots [1]$$

Stresses in the Blades. A second consideration which tends to limit the maximum length of a blade has to do with the requirement that the blade should have a sufficient factor of safety with respect to its mechanical strength.

Turbine blades are stressed in two different ways, namely: in tension by the centrifugal force of the mass of the blade, and in bending as a result of the pressure which the steam jet exerts on the blade and—in superpressure turbines—also by the difference between the specific steam pressure on the entrance and exit sides of the blades. The tensile stress is determined in a simple manner.

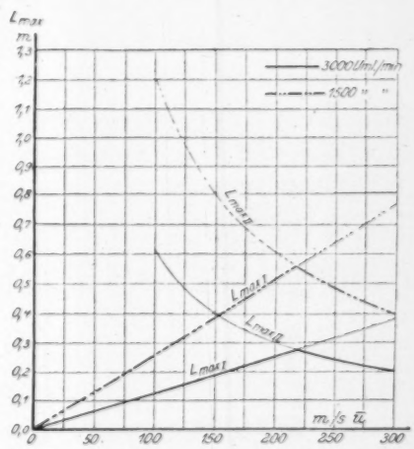


FIG. 3 DEPENDENCE OF MAXIMUM BLADE LENGTH ON THE PERIPHERAL SPEED
(*Uml/min.* = r.p.m.; *m/s* = meters per sec.)

If F is the cross-section of a blade in sq. cm., which may be assumed to be the same throughout the blade, and if L is the length of the blade, R the average diameter of the wheel in meters, σ_z the tensile stress in kg. per sq. cm. in the cross-section of the blade at the fastening—which should have an area of mF sq. cm., where m is equal or less than unity (Figs. 1 and 2)—then the centrifugal force is—

$$C = \frac{FL\gamma u^2}{1000\, gR} = m F \sigma_z$$

From this may be computed the specific stress

$$\sigma_z = \frac{\gamma Lu}{1000\, mgR} \quad \frac{2\gamma\pi}{60 \times 1000\, mg}\, nLu = \frac{1}{C}\, n L u$$

and also the maximum length of blade L_{maxII} that will withstand a given centrifugal stress, assuming certain values for m, u and σ_z:

$$L_{maxII} = \frac{C\sigma_z}{\gamma n u} \quad \ldots\ldots\ldots\ldots [2]$$

As regards the bending stresses on a turbine blade, data are available from Stodola's book on steam turbines, (4th German edition, pp. 236 ff.). In many cases these bending stresses may be neglected.

If only centrifugal stresses be taken into consideration and if n and σ_z be taken as constant, then Equation [3] will obtain:

$$L_{\max II} = \frac{e'}{u} \quad \ldots\ldots\ldots\ldots\ldots\ldots [3]$$

This and Fig. 3 show that the connection between $L_{\max II}$ on one hand and u on the other hand is expressed by an equilateral hyperbola, while the connection between $L_{\max II}$ and u at a constant speed of rotation in revolutions is expressed by a straight line. Fig. 3 clearly shows that $L_{\max I}$ and $L_{\max II}$ represent the greatest permissible length of blade for small and larger values of u respectively, and that the greatest length of blade that can be used for a given number of revolutions n likewise increases at first with the value of u and then from a certain value of u on begins to decrease. It should be clearly borne in mind, however, that the value of $L_{\max II}$ has been in the first place determined only with respect to stresses produced by centrifugal force and that the calculation given above is based on certain assumptions which affect the value of $L_{\max II}$ very materially. Among such assumptions is that of equal cross-section F throughout the entire length of the blade. In many cases, especially where the blades are long and subjected to high stresses, the cross-section is reduced toward the head of the blade, the blade being made thinner at the end or narrower in the axial direction. With such a type of blade $L_{\max II}$ can be, of course, greater than it could have been with a blade with equal cross-section throughout.

Finally the numerical value of $L_{\max II}$ depends materially on the value of m, $m = 1$ requires that all weakening of the cross-section should be avoided at the places when the blade is held in the hub, which is easily done in the case of machined plates. On the other hand, in the case of rolled plates the plate is undercut in the insert. For this case $m < 1$ and $L_{\max II}$ has to be made of course smaller than for machined and unweakened blades.

The following table contains values for $L_{\max II}$ derived from Equation [2] with $m = 1$, $n = 3000$, $\sigma_z = 1500$ kg. per sq. cm. and $C = 93.9$, and gives the values of $L_{\max II}$ for different values of u:

u (meters per second)	100	125	150	175	200	225	250
$L_{\max II}$ (meters)	0.602	0.481	0.401	0.344	0.301	*0.268*	*0.241*

A comparison of this and the previous table shows that under the above assumptions $L_{\max II}$ passes into $L_{\max I}$ at about $u =$ 200 meters per second. The actual maximum blade length for each peripheral speed is indicated in both tables by italics. If one takes into consideration the bending forces in addition to the centrifugal stresses it is found that the passage from $L_{\max I}$ to $L_{\max II}$ takes place likewise under 200 meters per second.

In Fig. 3, in addition to the curves for $n = 3000$ r.p.m. are also given the curves for $n = 1500$ r.p.m. From this and Equations [1] and [2] it would appear that for the same values of u the maximum length of the blades increases with the decrease in n. (*Zeitschrift des Vereines deutscher Ingenieure*, vol. 65, no. 28, July 9, 1921, pp. 739–744, 10 figs., *t*.—Only the first part of the article has been abstracted. Further abstracts will appear in a early issue.)

Short Abstracts of the Month

AIR MACHINERY

Drier Air For Blast Furnaces

Air Conditions in Blast-Furnace Plants, with Special Reference to Moisture Content in Air, J. Bronn. The author made an extensive investigation of moisture content in air at various places around a blast-furnace plant, using a special recording apparatus called a "thermohydrograph," made by R. Fuess, of Steglitz, Germany. This apparatus records both the temperature of the air and the moisture percentage, from which it becomes possible to determine by proper tables the weight of water in a cubic unit of air.

These investigations have shown that the moisture content in air at an altitude of 30 meters (98 ft.) above ground level is about 20 per cent lower than at the ground level, both measurements being made in the neighborhood of a blast furnace. This led to an inquiry as to whether such a difference is universal or due to specific conditions surrounding a blast furnace, and surprisingly enough the author discovered that no reliable information was available as to moisture content at even low altitudes above the ground. A further investigation has indicated, however, that a difference of moisture content as high as that observed in the present instance was by no means universal, and was probably due chiefly to the fact that air even at an elevation of 100 ft. above the ground in the neighborhood of a blast-furnace plant is very much colder than at the lowermost level, and the author ascribes this to the tremendous amounts of heat delivered to the air from blast-furnace or rolling-mill plants.

In fact, he states that, roughly, each square meter (10.7 sq. ft.) of the area of a blast-furnace plant is heated daily by 3 kg. (6.6 lb.) of coke or coal, in addition to which there is a very large amount of water discharged every minute in the various cooling and washing devices. This leads the author to the conclusion that in order to obtain as dry air as possible for the blast furnaces it is of advantage to take this air from as high an elevation as possible.

In order to meet these conditions when in 1912 the blowing-engine house at the Rombach mills was being reconstructed, it was decided to place the suction orifices of all the eight gas-driven blowing engines into a common suction tower 42 meters (138 ft.) high. The new blower unit was not completed until 1915 and then war conditions made measurements difficult, particularly as neither an air hygrometer nor a registering moisture indicator could be used in connection with the suction tower, because of the very great vibration of the air flow, and all measurements had to be made by weight analysis which is a very time-consuming process. Nevertheless, fifty-three measurements were carried out, with the result that it was found that air taken through the top of the tower contained on an average 12 per cent less moisture than air at the ground level.

In this connection it is of interest to note that it was found that when the wind came from the east and particularly from the north-east, there was a rapid increase in the moisture content in air coming through the suction tower. This is explained by the fact that at the distance of some 50 meters (164 ft.) from the tower was located a tall stack discharging the exhaust of all the engines driving the blowers, and it was evidently the vapor from this exhaust that tended to increase the moisture content in the air.

The latter part of the paper presents a calculation indicating the importance from the point of view of economy of reducing as far as possible the moisture content in the air. This computation does not materially differ from several similar computations that have been published in this country. (*Stahl und Eisen*, vol. 41, no. 24, June 16, 1921, pp. 813–820, 7 figs., *e*)

BLAST FURNACES (See Air Machinery)

ENGINEERING MATERIALS (See also Metallurgy)

Alloys of Tellurium with Some White Metals, J. H. Ransom and C. O. Thiem. The experiments carried out covered alloys of tellurium with 50-50 tin-lead solder, and with lead, tin, zinc, aluminum and zinc-base die-casting metal.

Tellurium was added to the molten metals in comparatively small percentages. When it was added to the solder it burst into a glow and then seemed to form hard lumps which only slowly and in part disappeared. No samples of these lumps have been secured for analysis.

As regards the results obtained, it was found that in some cases the addition of tellurium reduced the amount of copper in the solder. No appreciable difference was found as being due to the addition of tellurium to lead and tin, but in the case of aluminum the tensile strength increased from 13,940 to 14,810 lb. and the elongation from 18.5 per cent to 28.5 per cent. In the case of zinc, no difference in elongation was found, but the tensile strength increased from 4955 lb. to 5510 lb. per sq. in. On the whole, it would appear that where metal dissolves tellurium the hardness and tensile strength are increased to an appreciable extent. In all cases investigated it is probable that tellurides of the metals are formed and that these are little soluble in the molten mass. (*Chemical and Metallurgical Engineering*, vol. 25, no. 3, July 20, 1921, pp. 102–103, 1 fig., *e*)

CAST IRON IN THE CONSTRUCTION OF INTERNAL-COMBUSTION ENGINES, P. W. P. It is claimed that when cast-iron bars are subjected to prolonged heat treatment at temperatures between 575 and 600 deg. cent. a partial decomposition of the pearlitic carbide takes place and that the extent of decomposition of carbide is greater in the comparatively silicon-rich alloys. This decomposition is almost complete when the silicon content exceeds 2 per cent.

The author therefore expresses the opinion that no subsequent treatment, no matter how thorough, will entirely overcome distortion due to repeated application of heat and that little advantage, if any, is to be gained from the standpoint of release of internal stresses set up by the primary crystallization produced during the cooling or freezing of the iron. He believes that it is necessary to select a material having a much lower silicon content than that contained in commercial gray cast iron, and he suggests that 1 per cent be considered the maximum for material to be used for cylinders and pistons of internal-combustion engines. (*Engineering and Industrial Management*, vol. 5, (new series), no. 26, June 30, 1921, pp. 736, *p*)

EFFECT OF CRUSHER SCREENINGS IN CONCRETE. Data of tests carried out in Canada which are claimed to show an increase in strength of concrete through use in the aggregate of crusher screenings in quantities up to 20 per cent.

Tests carried out have shown among other things that when 5 per cent of the weight of the crushed-stone proportion was added in the form of screenings, which is less than 3 per cent of the total mixture, the strength was increased from 2223 to 2729 lb. per sq. in., or 22 per cent. This is, however, not an entirely new fact.

Tests were also made to determine the effect of screenings from the upper rock as compared with those from the lower rock. It was found that mortars made with crushed sand are considerably stronger than those made with river sand. (*Cement and Engineering News*, vol. 33, no. 7, July 1921, pp. 19–21, 1 fig., *ce*)

LATENT HEATS OF FUSION OF NICKEL AND MONEL METAL. Walter P. White. Description of apparatus and methods used for determination of the specific heats of solid or liquid metals. The results found indicate that formerly published figures are in error by about 30 per cent.

The general method employed was that of heating the specimens of metal and then dropping them into a water calorimeter. The metal specimens were handled in closed and nearly exhausted silica glass tubes which protected them from oxidation and supported them while melted. Before exhausting, the tubes were filled with nitrogen to protect the metal during the inclosing process. The total heat of melted nickel is found by pouring the metal directly from crucibles into the calorimeter, using the first appearance of solidification to indicate the temperature—which was therefore the melting point (some practice was required in catching the right moment for pouring).

The latent heat of nickel was found to be 73 calories per gram, 17 calories greater than the determination of Wust (1918). The latent heat of monel metal, 68 calories, is in excellent agreement with that of nickel. (*Chemical and Metallurgical Engineering*, vol. 25, no. 1, July 6, 1921, pp. 17–21, 2 figs., *c*)

FUELS AND FIRING (See Power-Plant Engineering)

HOISTING MACHINERY

THE GRAPHICAL DYNAMICS OF A WINDING ENGINE, Charles D. Mottram. Description of the apportionment of the external losses in a large steam winding engine at a British colliery. These losses are determined at instants throughout a complete wind in horsepower and curves are plotted on time abscissae.

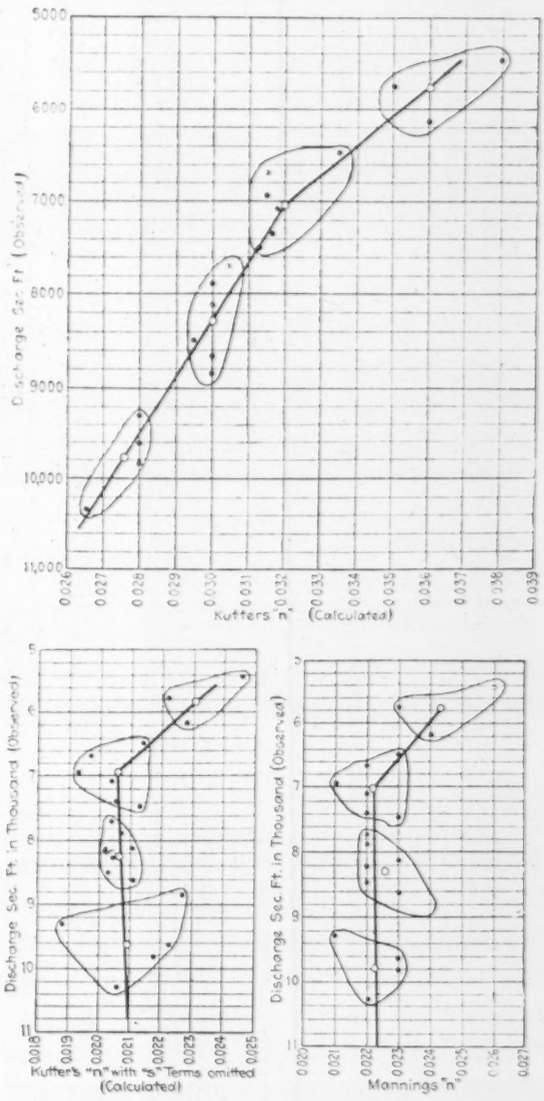
The velocity and acceleration throughout the wind were determined both on the full and on the empty side, this being done from a record automatically drawn by the engine. The record is a diagram showing ordinates proportional to the winding-drum speed in revolutions. On the recorder used in this instance the chart is carried on a cylindrical clock-driven drum varying less than a minute in 24 hours and thus giving an abscissa directly proportional to the time.

The interesting data presented in the paper are not suitable for abstracting. (*The Colliery Guardian and Journal of the Coal and Iron Trades*, vol. 121, no. 3155, June 27, 1921, pp. 1733–1734. 8 figs., *p*)

HYDRAULICS

MANNING AND KUTTER FORMULAS. In a résumé of four years' intermittent gagings of the flow through the main channel of the Sanitary District of Chicago, contributed to the *Journal of the Western Society of Engineers*, for Sept. 5, 1920, Murray Blanchard, formerly with the Sanitary District, now hydraulic engineer, Illinois State Division of Waterways, Chicago, who made the study, concludes that Kutter's formula to obtain the value of c in the Chézy formula $V = c\sqrt{(Rs)}$ will not apply. The value of n, computed and tabulated from measured discharges ranging from 5,000 to 11,000 sec-ft., is not a constant but increases in value with the decrease in discharge, as shown in Fig. 1.

Similar computation for n with Manning's formula, which for c in the Chézy formula gives $c = 1.486R^{1/6}n$, shows that n comes out a fairly constant value of 0.220 for all except the low discharge, as shown by Fig. 2.



FIGS. 1, 2 AND 3 COMPARISON OF VALUES OF n CALCULATED FROM OBSERVED DISCHARGES IN MAIN CHANNEL OF SANITARY DISTRICT OF CHICAGO

H. W. King, professor of hydraulic engineering, University of Michigan, in commenting on Mr. Blanchard's equation, states that eliminating the s, or slope terms, will give far more consistent results. Fig. 3, based on the Sanitary District records, gives for n a value somewhat less than 0.021.

Professor King states further that for some time he has been of the opinion that Kutter's formula will give just as satisfactory results without the s terms. It is his opinion that the Kutter formula has been used satisfactorily for many years because, in most cases, channels are constructed with slopes so great that the value of c is not generally affected by the inclusion of the slope terms. (*Engineering News-Record*, vol. 87, no. 3, July 21, 1921, pp. 96, 3 figs., *cl*)

INTERNAL-COMBUSTION ENGINES (See Engineering Materials; Lubrication)

LUBRICATION

The Carbonization of Lubricating Oils in Internal-Combustion Engines, Frederic H. Garner. The paper discusses the factors which cause decomposition of the oil in the engine, decomposition being considered the fundamental cause of carbonization. According to the opinion of the author, decomposition of oil in an engine can occur in two ways, namely:

First, rapid carbonization due to exposure of the oil (in the form of a fine spray or mist) to the explosion flame causing incomplete combustion of the oil; the result of such carbonization being the production of carbon and asphaltic material.

Second, gradual carbonization of the thin oil film on the piston and cylinder heads at temperatures of 200 to 400 deg. cent., giving first asphaltic material which is changed to carbon by the prolonged action of these temperatures.

The paper describes experiments to determine the evaporation losses and degree of carbonization for various oils and the estimation of the asphalt resin content of lubricating oils.

Among other things it was found that the evaporation losses of lubricating oils of similar boiling-point range were approximately the same whether the oils were derived from Texas or Pennsylvania crude.

It was also found that for similar oils there is a general relationship and that the higher the flash point of the oil, the lower is the amount of asphaltenes formed in a given time at a given temperature. Moreover, the rate of asphaltene formation appears to follow a mathematical law and decreases almost uniformly with rise in flash point and fire point of the oil. Direct carbonization increases much more rapidly than the evaporation loss, both as regards increase of time at a particular temperature and increase of temperature after heating for the same length of time. (*Journal of the Institution of Petroleum Technologists*, vol. 7, no. 26, April 1921, pp. 98–126, with discussion pp. 126–138 and bibliography 139–148, *eA*)

MACHINE PARTS (See Machine Shop)

MACHINE SHOP

Lantern Projector Apparatus for Inspection of Machine Work

Cold Swaging. Second of two articles describing the methods employed in making swaging dies, the first of which was abstracted n Mechanical Engineering, August 1921, p. 546.

An interesting feature is the use of a lantern projector apparatus for the inspection of swaging dies. The machine has a magnification of 50 diameters, which facilitates inspection of the condition of the dies either from a projectograph of the matrix of the die or of a piece of swaged work.

The projectographs reproduced in Figs. 4 and 5 emphasize the value of such an inspection means for detecting imperfections in the die surfaces. Fig. 4 shows a needle of 0.07 in. diameter after being swaged in a pair of dies, and enables the irregularities in the blade, produced either by wear or by improper machining, to be easily detected. Mention has been made in a previous paragraph of the quality of product which may be realized in the manufacture of threaded rods by swaging. The projectograph of swaged threads shown in Fig. 5 is self-explanatory. The thread form, it will be seen, is exceptionally good, although it is not in respect to thread form that the swaging process is most efficient, but rather in the lead.

On precision work such as the sizing of wire or for work encountered in needle manufacture, the existence of worn surfaces must be detected before it has advanced far enough to produce unsatisfactory work. The detection of this wear probably cannot be accomplished with such a degree of positiveness as by the use of the projectograph apparatus. (*Machinery*, vol. 27, no. 11, July 1921, pp. 1018–21, 8 figs., *d*)

Position of Lathe with Respect to Light. The general tendency is to place a lathe, when possible, in front of or near to a window, or under a top light, but only seldom is an effort made to secure any result beyond that of obtaining as ample light as possible.

An engineer who has done a considerable amount of research work in turning is credited with the statement that when a lathe has been moved from a position in front of a window facing to the west to one facing to the north, a much better view of the operations has been obtained.

Artists have for a long time endeavored to have their studio windows face north; weaving sheds and other workshops have also been planned to obtain north lighting. (*Model Engineer and Electrician*, vol. 45, no. 1054, July 7, 1921, pp. 1 and 2, *p*)

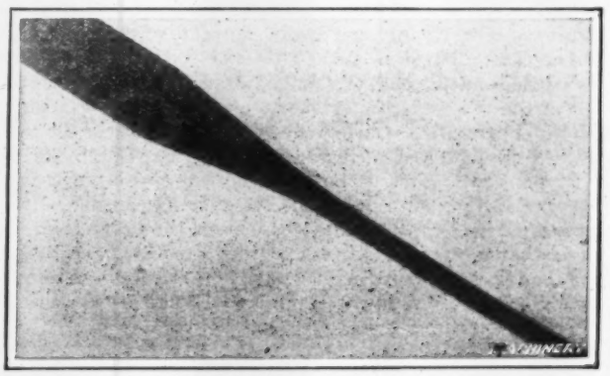


Fig. 4 Projectograph of a Needle of 0.07 In. Diameter

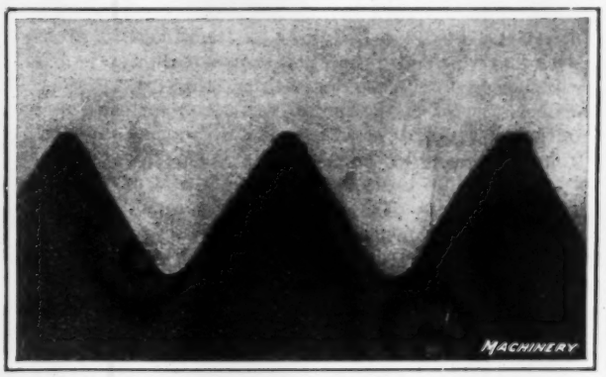


Fig. 5 Swaged Thread Projectographed to Show the Contour

Non-Metallic Gears

Design and Manufacture of Non-Metallic Gears, Fred R. Daniels. Description of the methods and processes employed in the manufacture of rawhide and micarta gears.

The raw material from which rawhide gears are made is the green packer hides cured and treated by processes that leaves mainly a fibrous structure. These processes reduce each hide to a thickness of approximately $^1/_{16}$ in., the hide being then blanked into circular disks or into rings or segments according to the requirements of the gear manufacturers. These blanked-out hides are then dipped into a vat of special glue and assembled between steel end blocks until a thickness of from 8 to 10 in. has been reached. Hydraulic pressure is next applied to squeeze out the surplus glue, after which the blank is kept compressed until dry, which may require several days.

Gears made from various fabric-base materials are said to resemble closely each other in physical characteristics. The fabric is first impregnated with compositions (condensation products of phenol and formaldehyde), after which a number of the blanks are bonded together under great pressure and application of heat. The rings or segments are cut from the impregnated fabric and placed in a suitable mold before the pressure and heat are applied.

Rings or segments are used in designs where a spider or bushing is the main support. Such constructions are employed where a stress on the key is likely to be greater than the material itself would be able to withstand if the gear were made of one solid blank. Micarta is frequently mounted on a hub center in such a manner that no additional mechanical retaining means are required.

Rawhide gears should not be subjected to a temperature in excess of 225 deg. fahr., neither must they become wet. Care must be therefore taken to provide suitable storage space for rawhide gears and when not in use the rawhide should be coated with shellac and kept in a cool, dry place. The life of the gear in service is greatly prolonged by the use of a lubricant consisting of a thin mixture of lard oil and graphite. Mineral oils should never be used as a lubricant for rawhide.

On the other hand, rawhide is as strong as cast iron at high speeds and gears are often used with peripheral speeds of from 1700 to 2000 ft. per min. or more. Rawhide can successfully compete with bronze from the viewpoint of ultimate cost, owing to its comparative length of service, but is somewhat higher as regards first costs.

A safe working load for rawhide pinions is 150 lb. per inch width of face for gears of 1-in. circular pitch. The working load for other pitches should be in proportion but should never exceed 250 lb. per inch of face width, and an allowance of from 20 to 25 per cent should be made for such conditions as overload, etc. The above figures apply only to pinions constructed without flanges and may be increased from 10 to 25 per cent for pinions with flanges.

Fabric-base materials are not affected by water or oil, not susceptible to the action of acids or alkaline solutions, and not attacked by rodents. They will not shrink at temperatures under 200 deg. fahr.

The specific gravity of these fabric-base materials is 1.4, the weight 0.05 lb. per cu. in., and the Brinell hardness from 30 to 40. The raw material has a tensile strength, parallel to the laminations, of 10,000 lb. per sq. in.; a compressive strength of from 35,000 to 47,000 lb. per sq. in. perpendicular to the laminations, and from 17,000 to 24,500 lb. per sq. in. parallel to the laminations; and a transverse strength, both parallel and perpendicular, of 17,000 lb. per sq. in. In figuring the strength of gear teeth by the Lewis formula, however, a safe working load greater than 5000 lb. per sq. in. should not be used.

The diametral pitch of gear teeth recommended for service is as follows: For smaller loads up to and including $\frac{1}{2}$ hp., 10 pitch; for 1 hp., 8 pitch; 2 hp., 5 pitch; 10 hp., 4 pitch; 15 hp., 2 pitch; 25 hp., $2\frac{1}{2}$ pitch; 50 hp., 2 pitch; 75 hp., $1\frac{3}{4}$ pitch; and 100 hp., $1\frac{1}{2}$ pitch. When heavier service than 100 hp. is encountered, the design of the gears should receive special consideration. The maximum recommended pitch-line speed is 2500 ft. per min. The greatest length of service for gearing is obtained when there is a good rolling contact; consequently the most desirable condition in non-metallic gear design is where there is a comparatively large number of teeth. Gears having less than fifteen teeth do not furnish good rolling contact, and they wear faster and vibrate more than when a finer tooth is used. It may even be good engineering to redesign the entire gear train in order to use gears of smaller pitch.

The article gives extensive information on the design and machine methods of these gears and also illustrates several of the designs of the gears. (*Machinery*, vol. 27, no. 11, July 1921, pp. 1005–1011, 12 figs., *d*)

MILLING SLENDER CASTINGS. Description of the fixtures and processes used by the Remington Typewriter Co. Of particular interest is the discussion of the effect of rate of feed or distortion of work.

It was found that the rate of feed used for milling has a decided influence on the distortion of such slender parts as the bed and carriage rails of the typewriter. When a fine feed is used there is considerable distortion, but when the feed is coarse the distortion is not great enough to cause trouble.

The explanation given for this fact is as follows: Milling often leaves on the surfaces uniformly spaced revolution marks caused by some irregularity of the cutter such as the presence of a tooth which differs slightly from the others. As this irregular tooth comes around, it strikes the work with greater force than the others. This irregularity while slight, may have, nevertheless, a pronounced effect on the work when the feed is fine because the "peening" action, due to the irregularity of the cutter, is greater or occurs often in a given length with the fine feed than with the coarse feed; consequently there is greater distortion with the fine feed. (*Machinery* (London), vol. 18, no. 456, June 23, 1921, pp. 356–358, 4 figs., *dp*)

MACHINE TOOLS

Inclined Wheel Grinders

PHANTOM WHEEL GRINDERS, Ellsworth Sheldon. Description of a new type of grinder of American manufacture.

The device was invented primarily for grinding extremely thin pieces of hardened steel. The pieces are not absolutely flat when they come from the hardening process to the grinding operation and will not lie still under the wheel unless packed. Packing each piece to grind first one side and then the other alternately would render the cost prohibitive, even if it were possible mechanically. A magnetic chuck could not be used because some of the pieces were so thin that even the pull exerted by it would distort them. To handle these wheels a special bearing was provided, but its character was such that there was no very efficient way of conducting the heat away from the piece being ground. Furthermore, a solid wheel wide enough to cover the surface of the work would quickly sweep the pieces off the chuck or would overheat them, and a very narrow wheel that would enable the operator to avoid both these troubles would take a long time to traverse over the width of the piece, besides being likely to induce distortion because of the slow progression of the hot spot across the work.

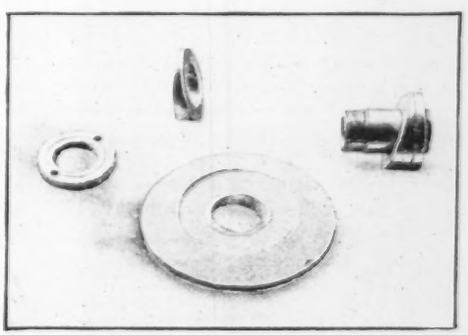


FIG. 6 PARTS OF THE PHANTOM GRINDING WHEEL

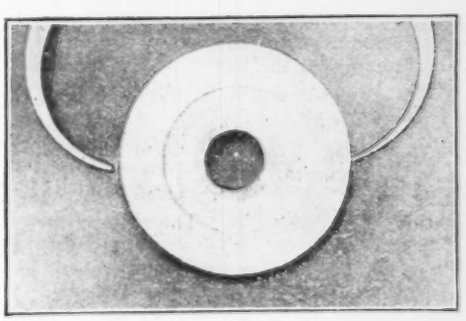


FIG. 7 ELLIPTICITY OF THE PHANTOM GRINDING WHEEL

It was to avoid these troubles that the "phantom" wheel was developed.

The parts of the phantom wheel are shown in Fig. 6. A standard grinding wheel 7 in. in diameter and of about $^1/_2$ in. width of face was first mounted in the usual manner and dressed to the shape shown in the figure, leaving a very narrow face. A sleeve was then fitted with a pair of collars, one face of each collar being machined to form an angle of about 15 deg. with its axis.

These collars are keyed to the sleeve. The lead bushing of the grinding wheel is then dug out to allow the wheel to tilt to an angle corresponding to that of the collars, a ring nut holding the whole combination together.

When the whole combination is first mounted on the grinding machine the periphery of the wheel does not run true. There are two high and two low spots. In other words, the wheel, though round of itself, will appear to be elliptical. To correct this condition the periphery must be redressed and thereafter the ring nut that binds the parts together must not be slackened; for the wheel that now presents a truly circular periphery to the work is in fact elliptic, as may be seen in Fig. 7, and as is shown by the calipers; the actual difference between the larger and smaller diameter with a wheel initially 7 in. in diameter amounts to about $^3/_{32}$ in.

The grinding action of the wheel is in effect the same as that of a solid wheel of the width equal to the scope of gyration, but the action may be represented as a series of contacts progressing back and forth across the work in a direction at right angles to its lineal advance.

When in motion the solid lines of the wheel disappear and, though the wheel is grinding with the apparent continuity of a solid wheel of 1 in. face and throwing sparks clear across the work, the work is at no time concealed from the operator's view.

Furthermore, because of the narrow surface in contact with the work at any time, comparatively little heat is generated and it becomes possible to cover the entire surface of the work without side traverse and with little danger of drawing the temper.

The original article shows a rather unusual method of dressing the wheel in which the diamond is placed at an angle of 45 deg. (*American Machinist*, vol. 55, no. 2, July 14, 1921, pp. 44–45, 5 figs., *d*)

METALLURGY

High-Temperature-Resisting Alloys for Carbonizing, A. Bensel. In two of the processes of case carbonizing, namely, pack carbonizing and liquid-bath carbonizing, the parts are packed in containers and it is claimed that cast-iron and steel containers are badly distorted in a relatively short time, with the result that it is impossible to load a furnace evenly. It is also stated that cast-iron and steel containers are subject to the formation of scale. While this scale clings to the box it makes the heat penetration poor, and when it drops off the walls become thinner and more heat is supplied to the work than should be.

The material for containers should be such that it will not easily carbonize, is not brittle and is capable of being machined. It should have a high tensile strength and retain much of that strength at the usual operating temperatures.

The alloy developed for this purpose is said to have the following characteristics:

Percentage composition: Nickel, 60; chromium, 12; iron, 26; carbon, silicon, manganese, etc., 2.
Melting point, 2660 deg. fahr.
Safe working temperature, 2000 deg. fahr.
Specific gravity, 8.15; Weight per cubic inch, 0.29 lb.
Specific heat, 0.111 at 100 deg. cent.
Brinell hardness number, 179
Scleroscope hardness, 27 to 30
Coefficient of linear expansion over temperature range from 0 to 100 deg. cent., 0.0000121
Thermal conductivity is 0.0341 cal. per cm. per sec., or a ratio of 1 to 4.888 with soft iron; or expressed in percentage, 20.5 per cent of the thermal conductivity of soft iron

The following tests were made on a 1-in. diameter specimen:

Tensile tests at 70 deg. fahr.:
Elastic limit, 40,000 lb. per sq. in.
Ultimate tensile strength, 54,000 lb. per sq. in.
Elongation, 1.00 per cent
Reduction of area, 2.50 per cent

Tensile tests at 1500 deg. fahr.:
Elastic limit, 20,100 lb. per sq. in.
Ultimate tensile strength, 24,500 lb. per sq. in.
Elongation, 4.00 per cent
Reduction of area, 4.30 per cent

The use of such an alloy made it possible to design a round container with a machined taper-fit cover which goes snugly into the container and closes it as a ground-glass-stoppered bottle. (*Transactions of the American Society for Steel Treating*, vol. 1, no. 10, July 1921, pp. 598-601, *dp*)

PIPE LINES

Economics of Lagging Oil Pipe Lines

Pipe-Line Transportation of Hot Oil. Leonard L. Barrett Discussion of effect of applying insulating coverings to hot-oil pipe lines such as are found in the California, Texas, and Mexican fields, with special reference to the economic results to be obtained by such practice.

The rate of heat loss from a hot-oil pipe line has a governing effect upon the location of stations. As the temperature of the oil drops, due to loss of heat by radiation, the viscosity of the oil increases rapidly and a point is reached where it becomes necessary to install a pumping station and heaters to force the oil along. The low specific heat of crude oil (approximately 0.5) accounts in a measure for the rapidity with which the oil drops in temperature during its passage through the pipe lines, because for a given loss of heat the temperature of the oil will drop twice as fast as would that of water.

The chief advantage of a suitable insulating covering on the pipe line is found in the heat saving effected, as it permits to space farther apart the pumping and heating stations which form the principal element of cost in pipe-line construction. It is stated in this connection that the loss of heat to the air from a pipe covered with a 1-in. thickness of 85 per cent magnesia is 0.45 B.t.u. per sq. ft. of pipe surface per hour per degree temperature difference, while the bare-pipe loss in air is between four and five times as much and the ditched-pipe loss may even exceed that of pipe in air if the ground is wet.

An extensive calculation of the flow of viscous fluids, of spacing of pumping stations and temperature of oil during flow is presented. This is accompanied by temperature-distance curves, viscosity-distance curves, density-distance curves and calculation of thermal efficiencies obtained in practice.

As regards the coefficient of radiation, it is stated that the values given in the article for above-ground insulated lines are very reliable, likewise the values for above-ground uninsulated lines, though the latter have been determined only for still-air conditions and would have to be increased for air in motion. The value of the coefficient for ditched insulated and uninsulated lines cannot be considered as fully reliable.

The discussion of the economic aspects of the question brings the author to the conclusion that insulation of pipe lines would bring the following net savings, (based on present cost): A capital saving of $72,000 per 100 miles, an annual saving of $36,700 per 100 miles and a saving of 3.85 cents per 1000 barrel-mile cost. To this should be added the advantage gained through the protection of the pipe from electrolysis and the steadiness in operating conditions which is gained by eliminating all the trouble due to moist ground during rainy weather. (*Chemical and Metallurgical Engineering*, vol. 24, no. 26, June 29, 1921, pp. 1148–1152, 3 figs., *cp*)

POWER-PLANT ENGINEERING

Economic Features of Pulverized-Coal Firing

Pulverized-Coal Versus Stoker Firing, F. P. Coffin. Comparative data on the value of the two under different operating conditions. The author arrives at the conclusion that where great flexibility of operation is required, pulverized coal may prove preferable.

The development of the underfeed stoker has made the adoption of pulverized fuel more difficult, though improved machinery for its preparation may help in this respect. It is also claimed

that large plants can be equipped for the preparation and burning of pulverized fuel at less cost than for burning coal on stokers.

The most important advantage of pulverized-fuel firing is its ability to handle a wider range of coals than can be burned on stokers and the same furnace is available for burning all grades of coal in pulverized form. Another important advantage is the facility and economy with which fires may be banked and the ease with which they may be restarted when steam is wanted suddenly. This makes pulverized fuel especially desirable where the steam plant is used as a reserve unit either in connection with water power or to carry peak loads.

From a discussion of several large central stations the author finds that the coal consumed in banking fires and bringing them back into steaming conditions was in one instance 3.76 per cent of the annual consumption. In another system with 15 stations feeding into it, 1.5 per cent of the annual consumption, and in a third instance the coal used for maintaining banked fires ran from 5.5 to 6.5 per cent of the total coal used.

In the first of these systems the underfeed stokers could be economically banked, the consumption then being only 35 lb. per hour for each 5000-sq. ft. boiler, but 1500 lb. was required to bring the fire back into condition for operation. When a fire was allowed to go out, 1000 lb. of coal was left on the grate and credited to the plant, while 6000 lb. was required to light a boiler and bring it to steaming condition, ready to put on the line.

When coal is burned on stokers in stations that are used for stand-by service for a considerable part of the year, the consumption in banking fires is an appreciable item of expense. The amount of coal burned during banking periods varies with the service conditions. Banked fires are carried as "hot bank" or cold bank." "Hot bank" or "live bank" consists in carrying full steam pressure and having the fire in condition to get the boiler to the normal rating in from five to seven minutes. A "cold bank" or "dead bank" consists in burning only enough fuel to keep up a low steam pressure. On modern underfeed stokers the average hourly coal consumption during banking is about 0.05 lb. per sq. ft. of heating surface on live bank and 0.02 lb. on dead bank or 7.5 to 10 and 2.5 to 3.5 per cent, respectively, of the fuel at full load.

Where pulverized fuel is used, steam has been held over night with only a small drop in pressure and in the morning about four minutes' firing sufficed to bring the pressure up to normal.

This suggested that the equivalent of dead-banking conditions may be effected by burning fuel only under a single boiler in a battery and by maintaining a steam pressure in the remaining boilers by circulating either steam or hot water through them from the live boiler. This will keep the boilers hot and permit raising the pressure rapidly without undue overstrain.

A further advantage claimed for pulverized fuel is that it is more responsive to delicate control of combustion conditions than solid fuel. On a good station-load factor the investment required for a pulverized-coal installation is comparable with that required for a stoker installation, but as the load factor becomes poorer the pulverized-coal installation will cost less in proportion, provided the fuel requirements are sufficient to enable the preparation plant to operate at a good load factor. (*Power*, vol. 54, no. 2, July 12, 1921, pp. 52–54, 2 figs., *cp*)

POWER PLANTS (See also Pipe Lines)

CLEANING SURFACE-CONDENSER TUBES, D. W. R. Morgan. After discussing the economic importance of keeping the condensers clean, the author proceeds to a description of eight methods of cleaning, some of which appear to be very expensive and others lacking in efficiency. The following, however, are recommended for use under certain conditions. The use of adjustable rubber plugs is said to be well adapted to cleaning the tubes when the deposit is of a slimy nature. These plugs are inserted into the tubes and are driven through by compressed air or water pressure. Cleaners of the scraper type are applied in a manner similar to the adjustable rubber plugs. This method of cleaning applies particularly to cases where there is a brittle or hard deposit on the tubes. The sketch in Fig. 8 illustrates the arrangement required for either the adjustable rubber plug or the cleaner of the scraper type, in cases where the condenser head has been removed. The brackets which support the scaffold plank are bolted to the flange of the condenser and may be set at any elevation. The seat and foot rest are made in one piece and can be moved along the plank to the most convenient position. A $^3/_4$-in.quick-opening gate valve is supported from the foot rest and is controlled by the operator's foot. Large condensers are cleaned without taking the heads off; this eliminates the seat and foot support, and the $^3/_4$-in. valve is then located adjacent to the nozzle and is operated by hand.

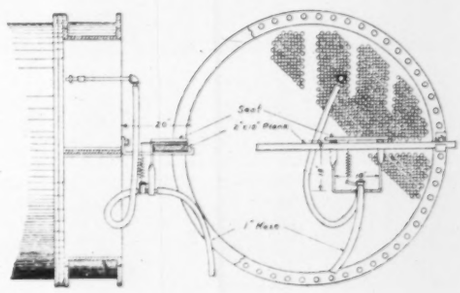


FIG. 8 ARRANGEMENT OF EQUIPMENT FOR CLEANING CONDENSER BY RUBBER PLUGS OR SCRAPERS (HEAD REMOVED)

The author does not believe in the efficiency of providing valve in the intake and discharge line of the condenser in order to reverse the flow of the water.

The ejector method applying low-pressure water and air at 80 lb. pressure to the tubes is illustrated in Fig. 9. The equipment consists of a $^3/_4$-in. tee into which the $^1/_4$-in. air nozzle *A* is inserted, thus forming an ejector. Nozzle *N* is flattened out so as to impart a spiral flow to the water. The air connection is made to point *A*

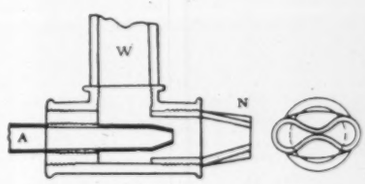


FIG. 9 EJECTOR FOR APPLYING LOW-PRESSURE WATER TO CONDENSER TUBES BY COMPRESSED AIR

and the water connection is made at *W*, using water at atmospheric pressure. It requires about five seconds to clean each tube properly with this method. (*The Electric Journal*, vol. 18, no. 7, July 1921, pp. 313–315, 6 figs. *d*)

REMOVING SCALE FROM SURFACE-CONDENSER TUBES WITH HYDROCHLORIC ACID, Norman G. Hardy. Date obtained from the practice of the Arizona Copper Co., at Clifton, Ariz., where hydrochloric acid has been used to clean condensers for the last two years. It is not claimed that this method is entirely satisfactory or that it is suitable under all conditions, but it has given very good success at the plant.

The general arrangement of apparatus is shown diagrammatically in Fig. 10. The condensers in this outfit have a tube area of 7600 sq. ft. in 2500 Muntz metal tubes $^3/_4$ in. in diameter by 15 ft. 1 in. long. The condensers have two passes with a vertical diaphragm between the water inlet and outlet compartments.

Before using the acid, both heads are removed from the water boxes, the tubes are washed out with a hoset he scale is cleaned from the water boxes, theheads, and, so far as practicable, from the tubes sheets also; after drying thoroughly, water boxes, heads and tube sheets are painted with two coats of roofing cement, to eliminate all chances of corrosion of the permanent parts of the condenser.

At first an acid-proof paint was tried, with the idea of maintaining a coating that would only have to be replaced occasionally, but it was found that the coating would not remain serviceable from one cleaning to the next. After trying several asphaltic paints, it

was decided that roofing cement, such as is ordinarily supplied for cementing the seams of prepared roofing, was best because it is sufficiently acid-resistant, can be easily applied, and dries quickly.

Cover plates with gaskets are next fastened over water inlet and outlet with capscrews tapped into the water box. The heads are then replaced and the apparatus connected up as indicated in the figure.

Vent pipes about 12 ft. long are placed at the top of each water compartment. The water boxes are tapped for $1^1/_2$-in. pipe and have a short nipple and reducer to connect to the 3-in. vent pipe. These vent pipes are very necessary, and it has been found that gas will blow water over if a height of less than 12 ft. is used. To circulate the solution, a 2-in. brass centrifugal pump with direct-connected motor drive is used.

The acid used is commercial hydrochloric, averaging about 24 per cent HCl. It is estimated that the water boxes and tubes will hold 7800 lb. of water, and 1000 lb. of acid is used for cleaning, making the solution about 3 per cent HCl. A stream from a $^3/_4$-in.

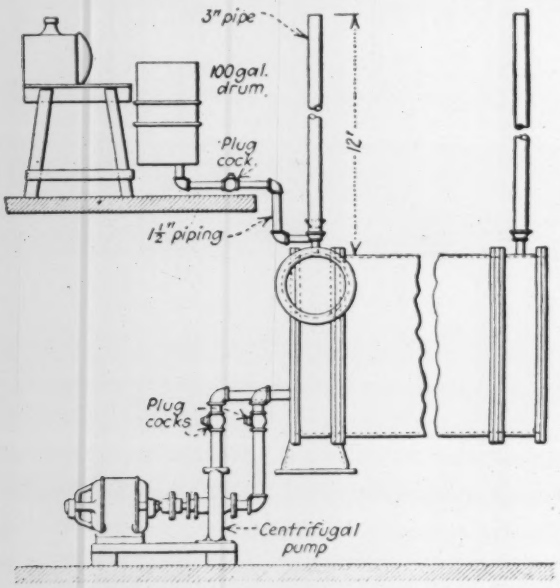


FIG. 10 ARRANGEMENT OF APPARATUS FOR CLEANING CONDENSER WITH HYDROCHLORIC ACID

hose is used for supplying water and the time required to discharge a measured quantity to the mixing tank is noted. From this the length of time necessary to empty one carboy of acid, with water flowing into the tank continuously, is calculated. Having the outlet from the mixing tank open, the water from the hose and the acid from the carboy are delivered into the mixing tank at a predetermined rate, whence they flow into the condenser continuously until it is filled. This is a rather crude method of proportioning the mixture, but it has been satisfactory in practice.

As soon as the level of the solution in the condenser rises above the pump suction, the pump is started. It is kept running for four to five hours, by which time the acid is entirely neutralized. The solution is usually not drained from the condenser until the following day.

The amount of scale actually dissolved is relatively small, being equivalent to a thickness of about 0.001 in. for the condenser and mixture described. But the great benefit of acid treatment is that it softens and loosens scale, so that it can easily be removed by washing and brushing. For this reason, if the condenser is very dirty, it will probably be more economical to treat it several times with a weak solution, washing out the loosened material between treatments, than to use a stronger solution.

The principal objections to the use of acid for cleaning are high cost and the possibility of injury to tubes and packing. The first of these is undoubtedly justified and eliminates this method in any case where the tubes are in good condition and the scale is not too hard to permit mechanical cleaning.

With regard to the second objection, it can be positively stated that the experience of the Arizona Power Co., Ltd. for two years past does not indicate any serious deterioration of tubes as a result of the use of acid for cleaning. (*Power*, vol. 54, no. 1, July 5, 1921, pp. 22–24, 1 fig., *b*)

SPECIAL PROCESSES (See Machine Shop)

Charcoal-Iron Boiler Tubes

THE MANUFACTURE OF CHARCOAL-IRON BOILER TUBES. Description of the processes employed by the Parkesburg Iron Co., Parkesburg, Pa. The processes are of interest, partly because of the considerable use of this kind of tubes and also because of the fact that the manufacture has been to an unusually slight degree affected by the general processes of mechanization of modern industry.

The first stage in manufacture is selection of scrap to go into the melt. Metal containing copper, tin, nickel, chromium or more than one-half of one per cent silicon is considered to be unfit for use, as these elements tend to make he finished product dry or brittle and unweldable.

The charges, in not more than 300-lb. lots, are placed in small forge fires in furnaces which to all intents and purposes have not changed in design in the last thousand years. In a rectangular hearth about 16 in. deep by 2 ft. square with a cast-iron box about 3 ft. high and open in the front, the charges are slowly melted in incandescent charcoal, the required oxygen being furnished by a blast of air entering the charcoal bed at an angle at about half its depth. Under the action of the blast the light scrap begins to melt and during the heating the impurities such as carbon, manganese, silicon and sulphur are slowly oxidized, a relatively large proportion of iron also undergoing the same process. The oxides unite to form a high basic slag with a comparatively low melting point and therefore quite fluid.

Gradually the mass becomes a conglomeration of microscopic grains of pure plastic iron, each covered or glazed with a film of slag.

The incandescent lump is then removed to a steam hammer where it is forged or "shingled" to a bloom about 30 in. by 5 in. by 6 in. Before it is placed under the hammer the lump resembles a sponge with the holes filled with molten slag, and the whole covered with a husk of iron oxide and partly consumed charcoal. Under the hammer most of the slag between the grains of the iron is forced out. From the hammers the hot blooms are passed to a reheating furnace and then rolled into bars. In this process the balance of the slag is almost entirely worked out.

After cooling, the bars are sheared into the required length, reheated and rerolled in a two-high plate mill. The rolling is done transversely, that is, the length of the pile is parallel with the axis of the rolls. The pile is run through the mill until the length of the resulting slab is equal to the desired width of the finished plate. The slab is then turned through 90 deg. and rolled for length and thickness to give the iron cross fiber or additional strength across the grain. The metal is always rolled in the same direction, and the few impurities left are worked to one end of the plate, which is cropped off and a much better surface is obtained.

The plates are next trimmed into strips of the proper width to make the tubes ("skelp").

The rest of the operations do not materially differ from the manufacture of welded tubing of other kinds. (*The Boiler Maker*, vol. 21, no. 7, July 1921, pp. 187–190 and 212, 9 figs., *d*).

STEAM ENGINEERING (See Power Plants)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society. The Editor will be pleased to receive inquiries for further information in connection with articles reported in the Survey.

ENGINEERING RESEARCH

A Department Conducted by the Research Committee of the A.S.M.E.

Engineering Research at Michigan

THE report of Prof. A. E. White, Director of the Department of Engineering Research at the University of Michigan, made to the third meeting of the Executive Committee of the Advisory Board, outlines the plans of the department. The report shows the great value of the industrial products of Michigan and comments on the work done at the Mellon Institute, the M.I.T. and the University of Illinois, and from this points out the opportunity for development of the department of research at the University. The department has an Advisory Board of one hundred men made up of the leading business men of the state and divided into groups according to the industries to which they belong. These subdivisions will be called Committees; and the chairman of each Committee will be empowered to enlarge the Committee when necessary. These sub-committees will confer with the Director of the Department of Engineering Research on problems and policies and on the methods of solving various research problems. The University has placed all of its facilities at the service of the Department of Engineering Research.

The method of financing various research investigations has not been decided on. Six plans are suggested:

1 All cost of investigation cared for by interested parties
2 Investigations financed from income from the state
3 Investigations financed from funds of an association formed for this purpose
4 Joint financing: industries provide funds, state provides building
5 Joint financing: industries provide building, state provides endowment
6 Industries provide buildings and endowments.

Locomotive Testing

The Locomotive Testing Laboratory of the University of Illinois is one of the largest laboratories for this purpose and in some respects the best-equipped locomotive laboratory in existence. The expense of operating it, however, is great, and for that reason little work is being done. It is hoped that steps may be taken by certain railway interests to use the laboratory for the purpose of research regarding the action of locomotives. It is believed that the authorities of the University of Illinois are willing to donate the use of the laboratory provided interested parties would finance the maintenance of the Research Staff and the purchase of coal and necessary supplies. This cost would amount to $60,000 per year, exclusive of any rental which might be charged the company furnishing the locomotive for test. The use of this laboratory for an investigation of locomotive problems would probably lead to extensive savings in the use of coal and other supplies. Address Dean C. R. Richards, University of Illinois, Urbana, Ill.

Research Résumé of the Month

A—Research Results

The purpose of this section of Engineering Research is to give the origin of research information which has been completed, to give a résumé of research results with formulas or curves where such may be readily given, and to report results of non-extensive researches which, in the opinion of the investigators, do not warrant a paper.

Apparatus and Instruments A7–21. Hygrometer. Technical Note 148 of the Forest Products Laboratory is on the Care and Use of Hygrometer in Kiln Drying. The note states that each thermometer of the hygrometer should be compared with the standard thermometer before using and a record noted. The hygrometer reservoir should be filled with pure water only. It is important that the silk or muslin covering of the wet bulb be kept in good condition at all times. A small amount of solid material is always left in the meshes after evaporation and this impedes distribution of moisture. The hygrometer should be placed at the exact points at which information is desired. Do not place it near door, wall or radiator. Such positions are not representative. In reading wet bulb sufficient air circulation should be present to give maximum evaporative rate from covering. U. S. Forest Products Laboratory, Madison, Wis. Address Director.

Automotive Vehicles and Equipment A7–21. Brake Linings. An investigation on commercial brake linings is being made at the Bureau of Standards and the results of these tests will be published later. One of the preliminary results shows that the coefficient of friction between the brake band and drum may fall to one-third of its normal value when the brakes first become hot. On cooling the normal value is restored. Used linings do not show this effect to such a great extent. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Economics A1–21. Telephone Service. Circular 112 of the Bureau of Standards on Telephone Service has just been published and may be obtained at 65 cents per copy from the Superintendent of Documents. This circular describes the service which the telephone company sells, enumerating the elements of the service and how the grade of service is dependent on each. It describes the various instruments used and calls attention to what determines the grade of service furnished by various companies. It describes the regulatory commissions controlling telephone service and discusses the matter of plant extensions, abandonment of service, physical connections, accounting, valuation, rates, contracts, collections and discriminations, etc., etc. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Electrical Communication A1–21. Telephone Service. See *Economics A1–21.*

Fuels, Gas, Tar and Coke A12–21. Sulphur in Coal. The Analysis of the Sulphur Forms in Coal is the subject of Technical Paper 254 by Alfred R. Powell for the Bureau of Mines. The purpose of the paper was to test the method of Powell and Parr for the analysis of sulphur forms in coal, to determine its application and to indicate, if necessary, certain refinements in the process. The Powell and Parr method is described and the investigation proves it to give correct and accurate results and that dilute nitric acid will extract small amounts of organic sulphur from certain coals. This is in the unstable phenol-soluble form. In order to avoid this error it is recommended that pyritic sulphur be calculated from the pyritic iron value. The results show that acid extractions can be materially shortened by a shaking machine and that dilute nitric acid not only extracts the pyrites quantitatively but also the same iron and sulphur taken into solution by dilute hydrochloric acid. Hence dilute nitric acid extraction need not be extracted first with hydrochloric acid. The experiments showed that semi-bituminous coals and harder bituminous coals must be digested a long time with concentrated nitric acid before the organic matter will become completely soluble in ammonia. The research proved that the Eschka method is preferable to the sodium peroxide method for the analysis of sulphur in coal and the coal residue, unless the sodium peroxide used has a low and constant sulphur content. Bureau of Mines, Washington, D. C. Address H. Foster Bain, Director.

Heat A11–21. Constants of Transmission for Pipe Covering at High Temperature Differences. One of the thesis subjects at the Rensselaer Polytechnic Institute during the spring of 1921 was the investigation of pipe covering of the Philip Carey Company of Cincinnati. Three types were tested: Carey Carocel, consisting of numerous laminations corrugated longitudinally with about ten layers per inch; Carey Multiply, a laminated covering made up of numerous rough-surfaced asbestos sheets of about 32 layers per inch, and Carey 85 per cent Magnesia. These coverings were tested in single, double and triple thicknesses—approximately 1 in., 2 in. and 3 in. The constant k of transmission was computed from the formula—

$$\text{Heat} = k 2\pi L (t_1 - t_2) / \log_e (r_2/r_1)$$

in which L = length in feet, $(t_1 - t_2)$ = temperature difference in deg. fahr., and r_2 and r_1 are respectively the radii to the outside and inside of covering.

The results of the tests are shown in Figs. 1 and 2. Fig. 1 indicates that in general the coefficient of heat transfer increases with the temperature difference in 1-in. covering, and as the thickness of the covering increases the coefficient remains more nearly constant. The variations of the coefficient with thickness of covering at temperature differences of 200 deg. and of 600 deg. are indicated in Fig. 2. Rensselaer Polytechnic Institute, Troy, N. Y. Address Arthur M. Greene, Jr.

Heat A12–21. Heat Transfer to Oil. The Coefficient of Heat Transfer from Steam to Oil through Steel Pipe has been the subject of a thesis at the Rensselaer Polytechnic Institute. The results of this thesis

are shown in the curves of Fig. 3. The oils used were as follows:

450 Red—Kendall Refining Company.
Specific gravity..... 31 deg. B.
Viscosity..... 181 Saybolt at 100 deg. fahr.
Flash point..... 356 deg. fahr.
Burning point..... 451 deg. fahr.

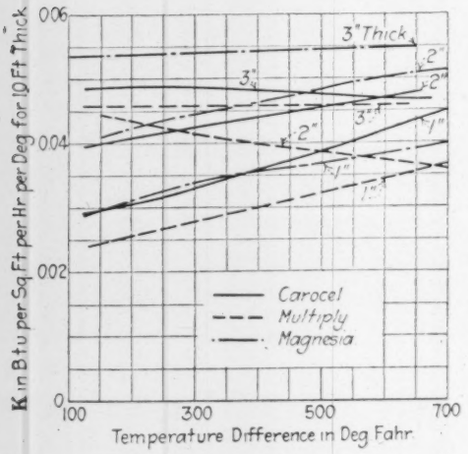


Fig. 1 Variation of Coefficient of Heat Transfer with Temperature Difference

600 Cylinder—Kendall Refining Company
Specific gravity..... 25.5 deg. B.
Viscosity..... 95 Saybolt at 212 deg. fahr.
Flash point..... 428 deg. fahr.
Burning point..... 550 deg. fahr.
Kerosene—Commercial Kerosene of the Standard Oil Company
28–30 Petroleum Fuel Oil—Standard Oil Company
Specific gravity..... 30.8 deg. B.
Viscosity..... 51 Saybolt at 100 deg. fahr.
Flash point..... 205 deg. fahr.
Burning point..... 300 deg. fahr.

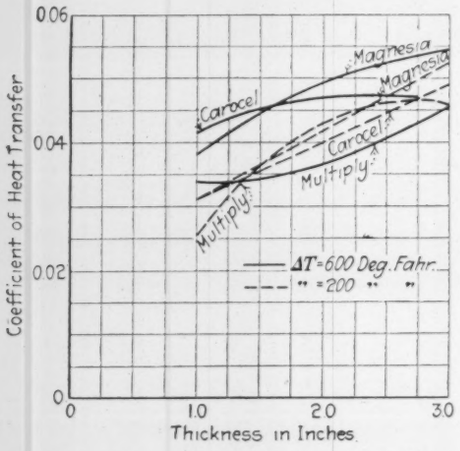


Fig. 2 Variation of Coefficient of Heat Transfer with Thickness of Covering at Temperature Differences of 200 and 600 Deg. Fahr.

Crude Oil—Standard Oil Company
Specific gravity..... 33.4 deg. B.
Viscosity..... 53 Saybolt at 100 deg. fahr.
Flash point..... 110 deg. fahr.
Burning point..... 136 deg. fahr.

The 14–16 fuel oil was not tested for physical properties. Rensselaer Polytechnic Institute, Troy, N. Y. Address Arthur M. Greene, Jr.

Illumination A1–21. Prof. E. H. Waldo has investigated the distribution of incandescent street-lighting units and has found that the statements issued by the various companies producing the units are substantially correct. Address Dean C. R. Richards, Engineering Experiment Station University of Illinois, Urbana, Ill.

Internal-Combustion Motors A3–21. Water Injection with Kerosene as Fuel. One of the undergraduate theses at the Rensselaer Polytechnic Institute during the spring of 1921 has been the investigation of effect of injecting water with kerosene in an internal-combustion engine. The engine used was a 7-in. by 12-in. Fairbanks-Morse type horizontal gas engine fitted for various types of fuel. Water was allowed to enter with the kerosene and both the water and kerosene were preheated to 150 deg. fahr. by passing them through an iron tube heated by a bunsen burner. In all cases the amount of water injected was computed as that above the moisture in the air at 5.8 grains per cu. ft. The effect of the water injection is to reduce the initial explosion pressure and at full load the injection of water seems to decrease the fuel consumption. The decrease of explosion pressure increases the smoothness of operation of the engine and this seems to increase mechanical efficiency of the engine by giving greater pressures at more advantageous crank angles. At great quantities of water injection the mechanical efficiency decreases, and this is believed to be due to the tendency of the water to destroy the cylinder lubrication. Water injection seems to result in a cooler operation of the engine, as shown by the decrease in the amount of heat absorbed by the cooling water and the lower temperature of the exhaust gases. Fig. 4 shows the pounds of fuel per brake horsepower-hour at different ratios of kerosene to water, the curves indicating that 8 lb. of kerosene to 1 lb. of water gives the best result. Fig. 5 shows the effect of various amounts of water injected at different horsepowers. Fig. 6 shows the effect of water injection on the initial explosion pressure and Fig. 7 the effect of water injection on the mechanical efficiency. Rensselaer Polytechnic Institute, Troy, N. Y. Address Arthur M. Greene, Jr.

Metallurgy and Metallography A12–21. Centrifugally Cast Steel. Technologic Paper No. 192 of the Bureau of Standards dealing with centrifugally cast steel has just been issued. It may be obtained from the Superintendent of Documents, Washington, D. C. at 10 cents a copy. The experiments reported show that metal so cast shows physical soundness and freedom from chemical segregation. For certain shapes forging and boring operations may be eliminated. It is shown that subsequent heat treatment of such castings improves them and makes them comparable with forgings. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Metallurgy and Metallography A13–21. Corrosion of Soft Metals. The results of the investigation of corrosion will soon be published. The investigation has determined the extent of intercrystalline embrittlement of soft metals—zinc, aluminum and tin—as a result of prolonged corrosion. Lead has been previously studied. Although the effect of stress in accelerating this action in lead will be studied, the publication of the results is expected at an early date. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Mining, General A4–21. Gas Masks. Gas Masks for Gases Met in Fighting Fires is the subject of Technical Paper 248 issued by the Bureau of Mines. It is prepared by A. C. Fieldner, S. H. Katz and S. P. Kinney. It also contains a chapter on the Effects of Gases and the Treatment of Gas Poisoning by Y. Henderson. Bureau of Mines, Washington, D. C. Address H. Foster Bain, Director.

Mining, General A5–21. Safety Lamps. The Relative Safety of Brass, Copper and Steel Gauze in Safety Lamps is the subject of Technical Paper 228 of the Bureau of Mines by L. C. Ilsley and A. B. Hooker. The pamphlet describes the method of mixing the gas and air, the construction of the flame-testing galley, the method of mixing and the condition of the gauze at different times. The investigation includes:

1 Study of European reports on similar research
2 A selection of critical tests for a publication on safety
3 Obtaining enough material to duplicate such tests
4 The performance of check tests
5 A report and analysis of results.

The investigation checked the results obtained by Belgian investigators. For conditions of high temperatures steel proved superior to brass or copper, while at low temperatures the different materials were about equal. Brass proved more satisfactory than copper. The

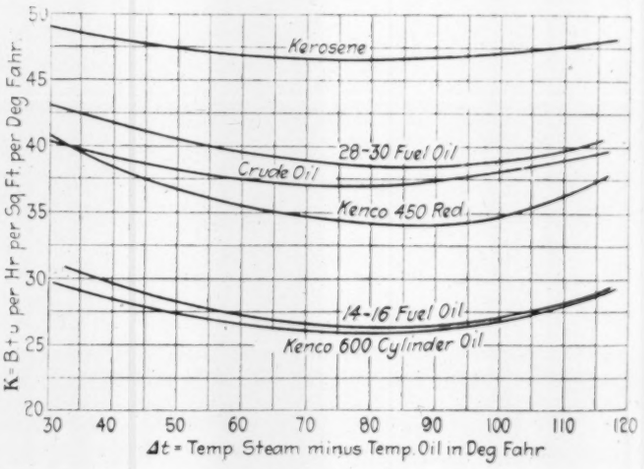


Fig. 3 Coefficient of Heat Transfer from Steam to Oil through Steel Pipe

least safe lamp of all tested was the single-gauze unbonneted lamp of the Davy type. The double-gauze unbonneted lamp is safer than a single-gauze lamp. The bonneted lamps were better than unbonneted lamps, the bonnet being more effective than an additional gauze. The safest lamp was the double-gauze bonneted lamp. The results indicate

that the present specification of Schedule No. 7 is not detailed enough. Bureau of Mines, Washington, D. C. Address H. Foster Bain, Director.

Petroleum, Asphalt and Wood Products A5–21. Bulletin 194 of the Bureau of Mines is devoted to some principles covering the production of oil wells. It is prepared by Carl H. Beal and J. O. Lewis. The bulletin describes the factors controlling the production such as the oil content of the ground, the ultimate production, the factors governing the decline of oil wells, the declining production of an oil property, the consideration of flush and settled production, and the life of oil wells. In addition the bulletin gives the publications on petroleum technology issued by the Bureau of Mines. Bureau of Mines, Washington, D. C. Address H. Foster Bain, Director.

Petroleum, Asphalt and Wood Products A6–21. UNDERGROUND CONDITIONS IN OIL FIELDS. Bulletin 195 on the Underground Conditions in Oil Fields by A. W. Ambrose is a publication of 238 pages. Its purpose is to point out the general method of procedure in studying underground conditions and to place before the petroleum industry the results of proper coöperation between the technical man and practical man. The bulletin would also serve as a guide to the engineer in solving oil-field problems and indicate to him studies that should be made in oil-field development. The bulletin is illustrated with charts, diagrams and halftones. Bureau of Mines, Washington, D. C. Address H. Foster Bain, Director.

Wood Products A5–21. WOOD RESEARCH. The Forest Products Laboratory has recently issued Technical Note 150 on the Effect of Direction of Fibers on the Strength of Fiber Boxes. Technical Note 151 on the Cause and Prevention of Blue Stains in Wood and Technical Note 152 on the Antiseptic Treatment of Wood Pulp to Prevent Mold and Decay. U. S. Forest Products Laboratory, Madison, Wis. Address Director.

B—RESEARCH IN PROGRESS

The purpose of this section of Engineering Research is to bring together those who are working on the same problem for coöperation or conference, to prevent unnecessary duplication of work and to inform the profession of the investigators who are engaged upon research problems. The addresses of these investigators are given for the purpose of correspondence.

Explosives and Explosions B1–21. GASEOUS MIXTURES. See *Internal-Combustion Motors B8–21.*

Frame Structures B1–21. INDETERMINATE STRUCTURES. A classification is being made of the source material on the subject of analysis of stresses in statically indeterminate structures which were published in Bulletin No. 108 of the Engineering Experiment Station, University of Illinois. The purpose of the research is to put the material in form for use by practical engineers. Address Dean C. R. Richards, Engineering Experiment Station, University of Illinois, Urbana, Ill.

Fuels, Gas, Tar and Coke B2–21. BREAKAGE OF COAL. Prof. H. H. Stoek and Messrs. L. R. Nylius and H. H. Huang are determining the breakage of different coals when dropped from different heights. Circular 6 of the Engineering Experiment Station discusses the apparatus used.

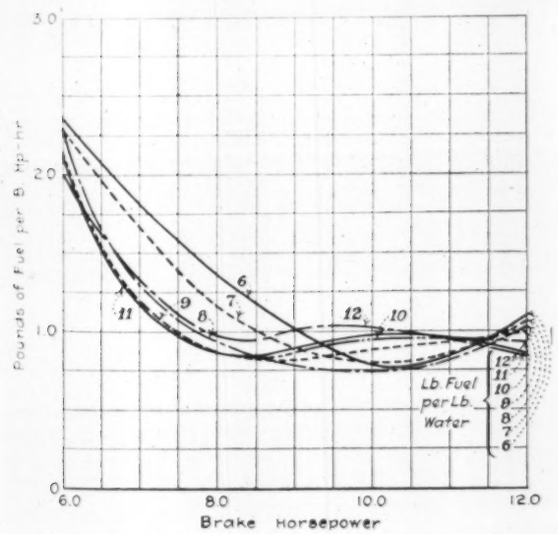


FIG. 4 FUEL REQUIRED PER BRAKE HORSEPOWER-HOUR AT VARIOUS RATIOS OF KEROSENE TO INJECTION WATER

See page 125. Address Dean C. R. Richards, Engineering Experiment Station, University of Illinois, Urbana, Ill.

Internal-Combustion Motors B7–21. IGNITION. A study of the electrical ignition systems for gasoline engines is being made under the direction of Prof. E. P. Payne by Mr. Y. Naito and others for the purpose of determining the relative amounts of energy delivered by sparks from various systems. The heat energy is being determined by a special calorimeter and the electrical phenomena are being determined by means of oscillograph records. Address Dean C. R. Richards, Engineering Experiment Station, University of Illinois, Urbana, Ill.

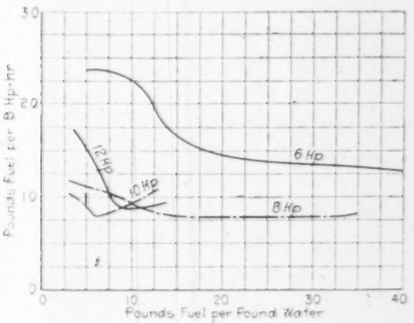


FIG. 5 RELATION BETWEEN FUEL CONSUMPTION PER B.HP-HR. AND RATIO OF FUEL TO INJECTION WATER

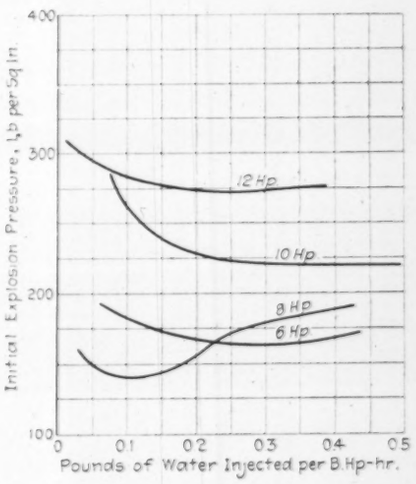


FIG. 6 VARIATION OF INITIAL EXPLOSION PRESSURE WITH AMOUNT OF WATER INJECTED

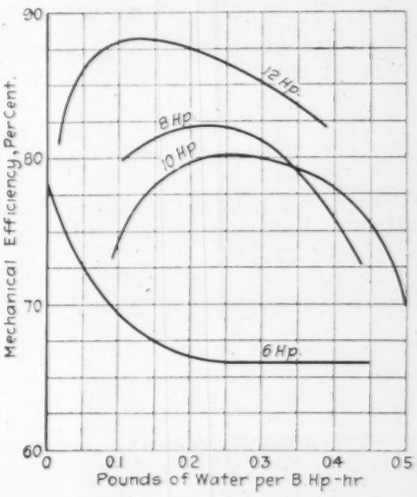


FIG. 7 VARIATION OF MECHANICAL EFFICIENCY WITH AMOUNT OF WATER INJECTED

Internal-Combustion Motors B8–21. EXPLOSION OF GASEOUS MIXTURES. Prof. A. P. Kratz and Mr. C. Z. Rosecrans are investigating the effect of shape of cylinder head, position of ignition plug and the effect of agitation of the gases upon the maximum pressure produced by explosion and on the time of explosion of gaseous mixtures. The pressure is measured by a specially designed diaphragm indicator making use of a spot of light, and time is determined by comparison with a photographic record made by a mirror on a tuning fork. Address Dean C. R. Richards, Engineering Experiment Station, University of Illinois, Urbana, Ill.

Internal-Combustion Motors B9–21. Internal Phenomena. An analysis of the thermal and chemical phenomena occurring in the cylinder of an internal-combustion engine is being made by Prof. G. A. Goodenough and Messrs. C. T. Felback and C. Z. Rosecrans. This work is almost complete. Address C. R. Richards, Engineering Experiment Station, University of Illinois, Urbana, Ill.

Machine Design B4–21. Riveted Joints. Prof. W. M. Wilson is investigating riveted joints subject to reverse stresses for the purpose of determining suitable working stresses for rivets and such joints and to determine the relative merits of different methods of driving rivets. Address Dean C. R. Richards, Engineering Experiment Station, University of Illinois, Urbana, Ill.

Machine Tools B3–21. Gear Measurements. Representatives of the Bureau of Standards have visited a number of gear manufacturers to obtain information as to the requirements of testing and measuring gears, cutters and hobs. A machine is now being designed to measure the important elements of gears and gear-cutting tools. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Mechanics B1–21. Pressure Through Granular Materials. Mr. L. M. Enger is determining the bearing pressure which granular materials will sustain under various conditions of size, angularity and restraint. Address Dean C. R. Richards, Engineering Experiment Station, University of Illinois, Urbana, Ill.

Mechanics B2–21. Rapid Loading. The strength and ductility of steel under rapid loading is being investigated by Prof. H. F. Moore. Address Dean C. R. Richards, Engineering Experiment Station, University of Illinois, Urbana, Ill.

Mechanics B3–21. Boiler Heads. The stresses produced in forming boiler heads are being examined by Prof. H. F. Moore in studying the effect of the rapid application of a load produced by the fall of a heavy weight. Address C. R. Richards, Engineering Experiment Station, University of Illinois, Urbana, Ill.

Metallurgy and Metallography B10–21. Tempering of Hardened Steels. The Bureau of Standards is continuing the work on this subject in the Metallurgical Division. The investigation deals with micro changes which occur during tempering. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Railway Rolling Stock and Accessories B2–21. Timber for Freight-Car Construction. For the antiseptic treatment of timber used in freight-car construction, see *Wood Products B2–21.*

Steam Power B1–21. Air-Steam Mixtures. Dean C. R. Richards and Mr. L. A. Wilson are investigating the thermal efficiencies of a small Corliss engine using various mixtures of compressed air and steam, the quantity of air being determined by a venturi meter and the amount of steam being determined by condensation. Address Dean C. R. Richards, Engineering Experiment Station, University of Illinois, Urbana, Ill.

Ventilation B1–21. Friction and Power Loss. Prof. A. C. Willard and others are preparing to investigate the friction and power requirements for supplying and exhausting air from the projected vehicular tunnels under the Hudson River. The air ducts in this case will be made of concrete with concrete elbows. The air discharge will be uniform from the side of the experimental duct. Address Dean C. R. Richards, Engineering Experiment Station, University of Illinois, Urbana, Ill.

Wood Products B2–21. Freight-Car Floor Timbers. The antiseptic treatment of timber used in freight-car construction is the subject of a research to determine the best commercial method therefor. Open-tank and brush methods of treatment on air-dried timber have been tested after cutting to dimensions. Tongue-and-groove joints, lap joints and common joints have been used with each type of treatment. Floors are assembled and placed in a position exposed to the weather. Address Dean C. R. Richards, Engineering Experiment Station, University of Illinois, Urbana, Ill.

C—Research Problems

The purpose of this section of Engineering Research is to bring together persons who desire coöperation in research work or to bring together those who have problems and no equipment with those who are equipped to carry on research. It is hoped that those desiring coöperation or aid will state problems for publication in this section.

D—Research Equipment

The purpose of this section of Engineering Research is to give in concise form notes regarding the equipment of laboratories for mutual information and for the purpose of informing the profession of the equipment in various laboratories so that persons desiring to conduct special investigations may know where such work may be done.

Aircraft D1–21. Large Wind Tunnel. See *Apparatus and Instruments D1–21.*

Apparatus and Instruments D1–21. Large Wind Tunnel. The Aerodynamics Section of the Bureau of Standards is constructing a new tunnel 10 ft. in diameter. This will give exceptional facilities to all types of research work involving the study of the behavior of objects in a wind stream. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

University of Arizona D1–21. The Mechanical Laboratory is provided with the following equipment:

75-hp. internally fired boiler and accessories
A small vertical boiler
Three high-speed engines, gasoline engine and automobile motor
Pelton wheel
Turbo-blower
A single-stage and double-stage centrifugal pump
Duplex direct-acting steam pumps and instruments for testing and calibration.

The power plant of the University is also used for a mechanical laboratory. Address Professor A. J. Wiechardt, University of Arizona, Tucson, Ariz.

University of California D1–21. The following equipment at the University of California is modern, dating from 1916. The equipment is noted under various Experiment Stations at which certain experiments are performed:

General:

Experiment Stations 100 to 109. Comprising calibration apparatus for thermometers, pyrometers, gages; lubricators; indicator and manograph study; valve, valve-gear and governor study from one simple and one Stephenson link compound engine; measurements of gases; measurements of vapors; orifices; measurement of power by prony brake, belt dynamometer, water brake, Sprague dynamometer, etc.

Fuels and Oils:

Experiment Stations 200 to 205. Comprising gas photometry; fuel calorimetry on the Parr, Junker and Hempel apparatus; fuel analysis; gas analysis; testing of lubricating oils.

Air:

Experiment Stations 300 to 305. Comprising Ingersoll-Rand compressor tests with variable-speed motor drive and belt dynamometer; Rider-Ericsson hot-air engine tests.

Internal-Combustion Engines:

Experiment Stations 400 to 406. Comprising tests on Continental motor, Ferro gas engine, Willys-Knight sleeve-valve engine, semi-Diesel engine, Westinghouse gas engine, Standard gas engine, Sprague dynamometer, etc.

Automotive Equipment:

Experiment Stations 500 to 514. Comprising work on Ford chassis; Willys-Knight sectional model; "Cut-away" chassis showing every moving part of a standard slide-gear car; magnetic gear shift; caterpillar tractor; Weidley engine; Buick engine; battery ignition systems; magnetos; rectifiers; Sprague dynamometer tests of generators and of starters; carburetors also in the official headlight testing laboratory of the State of California which is located in the building.

Steam:

Experiment Stations 600 to 610. Comprising steam calorimetry; study of steam auxiliaries such as traps, separators, valves, boiler-feed apparatus and boiler-feed-heating equipment; tests of steam pumps; injectors; tests on Ideal marine compound engines; complete tests of a Curtis turbo-generator; complete boiler test; complete power-plant test; study of section models of a Curtis 30-hp. turbine, of a Curtis 500-kw. turbine and of a 3000-kw. Westinghouse Parsons turbine.

E—Research Personnel

The purpose of this section of Engineering Research is to give notes of a personal nature regarding the personnel of various laboratories, methods of procedure for commercial work or notes regarding the conduct of various laboratories.

F—Bibliographies

The purpose of this section of Engineering Research is to inform the profession and especially the members of the A.S.M.E. of bibliographies which have been prepared. These bibliographies have been prepared at the request of members, and where the bibliography is not extensive, this is done at the expense of the Society. For bibliographies of a general nature the Society is prepared to make extensive bibliographies at the expense of the Society on the approval of the Research Committee. After these bibliographies are prepared they are loaned to the person requesting them for a period of one month. Additional copies are prepared which are available for periods of two weeks to members of the A.S.M.E. or to others recommended by members of the A.S.M.E. These bibliographies are on file in the offices of the Society and are to be loaned on request. The bibliographies are prepared by the staff of the Library of the United Engineering Society which is probably the largest engineering library in this country.

WORK OF THE A.S.M.E. BOILER CODE COMMITTEE

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, Mr. C. W. Obert, 29 West 39th St., New York, N. Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of the Society for approval after which it is issued to the inquirer and simultaneously published in MECHANICAL ENGINEERING.

Below are given the interpretations of the Committee in Cases Nos. 351 to 356 inclusive, as formulated at the meeting of May 12, 1921, and approved by the Council. In accordance with the Committee's practice, the names of inquirers have been omitted.

CASE NO. 351

Inquiry: Is it necessary, under Par. 2 of the Boiler Code, that welded or seamless circular furnaces or flues in boilers up to 18 in. in diameter as specified in Par. 241, must conform to the requirements for firebox plate material when exposed to the products of combustion?

Reply: It is not necessary that welded or seamless circular furnaces or flues up to 18 in. in diameter meet the specifications for boiler plate material. It is the opinion of the Committee that such boiler parts should be constructed from material fulfilling the requirements for lap-welded and seamless boiler tubes given in Par. 165 of the Boiler Code.

CASE NO. 352

Inquiry: Is it not permissible to construct boilers of the locomotive, economic or other portable types as coming under the classification of traction or portable boilers, as regards the attachment of lugs or brackets for which Par. 325 of the Boiler Code permits the use of studs with pipe threads? It is found impossible to properly rivet the lugs on certain designs of locomotive-type boilers where the lugs are to be located near the bottom of the waterleg of the firebox.

Reply: It is the opinion of the Committee that where the boilers of the portable type are to be fitted with lugs or brackets, the practice specified in the last sentence of Par. 325, of using studs, is permissible.

CASE NO. 353

Inquiry: Is it permissible, under the requirements of Par. 218 of the Boiler Code, to use stay tubes in place of through stays for supporting the surfaces around the manhole in the heads of h.r.t. boilers?

Reply: Stay tubes are not permissible for supporting the surfaces around the manhole in the heads of h.r.t. boilers.

CASE NO. 354

Inquiry: What are the requirements of the Heating Boiler Section of the Code, relative to the staying of flat surfaces of steel heating boilers designed to operate at a pressure not to exceed 15 lb. per sq. in.?

Reply: Par. 372 of the Code specifies a shop test of 60 lb. per sq. in. hydrostatic pressure shall be applied to steel or cast iron boilers used exclusively for low-pressure steam heating. It is the opinion of the committee that in staybolting a boiler of this sort, the stresses in the material should not exceed those allowable in power boiler practice which would necessitate computing the staybolts and their spacing for a working pressure of at least 40 lb. per sq. in., or two-thirds of the test pressure.

CASE NO. 355

(In the hands of the Committee)

CASE NO. 356

Inquiry: Is a boiler constructed as shown in the prints and described, safer under the Boiler Code Rules than other forms of similar boilers?

Reply: The Boiler Code Committee does not express opinions upon the relative merits of different designs of boilers. This is in accordance with the Constitution of the Society, C56 of which reads as follows:

> C56 The Society shall not endorse any commercial enterprise. It shall not allow its imprint or name to be used in any commercial work or business.

An interpretation of the Boiler Code is a proper action of the Boiler Code Committee and will always be given upon request.

"The A.S.M.E. Code Boilers"

The A.S.M.E. Boiler Code Committee has been apprised of the fact that several boiler manufacturers are following the practice of referring to boilers built to conform to the requirements of the A.S.M.E. Boiler Code as "A.S.M.E. Boilers." In fact, advertisements in the trade papers have actually appeared in which Code boilers are referred to in that form.

Inasmuch as this practice is erroneous and incorrect, the Boiler Code Committee suggests that manufacturers state that their boilers are built in accordance with the Boiler Code of The American Society of Mechanical Engineers, or should the manufacturers or any one else desire to refer to such boilers in a briefer way, that they designate them as "A.S.M.E. Code Boilers."

CORRESPONDENCE

CONTRIBUTIONS to the Correspondence Department of MECHANICAL ENGINEERING are solicited. Contributions particularly welcomed are discussions of papers published in this Journal, brief articles of current interest to mechanical engineers, or suggestions from members of The American Society of Mechanical Engineers as to a better conduct of A.S.M.E. affairs.

Appraisal Methods

TO THE EDITOR:

Appraisal and the determination of annual depreciation, which is an inseparable part of it, has until recently been almost wholly in the hands of accountants, but the recent problems involving capitalization which have been made an important issue on account of the income and excess-profits tax, have brought the engineer into the problem, so that at the present time we have two general methods of procedure in appraisals, i.e., the accounting method and the engineering method. The faults and weaknesses of the first are simple and easily exposed, but the weakness and liability to error of the engineering method, involving as it does the personal factor, are likely to be hidden in a mass of varying opinions.

The accountants' method consists in assuming a more or less correct total life of the property, and marking off an annual depreciation on a straight-line, logarithmic or some other purely mathematical basis. In prewar days this method, with a large factor of safety in the annual rate, was safe if not sound. It resulted in the extinction of values—on the books—which existed as a matter of fact.

The engineering method in its simplest form implies that the engineer can by his personal inspection determine the physical deterioration, the liability to obsolescence and inadequacy, and any other of the factors in the depreciation of the property under consideration. If he can do this he can justify his method. In so far as he relies on or colors his judgment with ideas of average length of life, he has departed from strict engineering methods. It will be seen, therefore, that while the accounting method depends but little on mental equipment of the appraiser, the engineering method relies on it almost entirely. If we not unreasonably assume any advantages for the latter method, it follows that they exist in fact only when applied by the right sort of man.

As a matter of fact and of practice the best results in appraisal are not secured by purely engineering methods as defined above, and one reason why the engineer is likely to make a better appraiser is that he is in a much better position to adopt any profitable accounting methods than the accountant is to adopt engineering methods. For example, there are at least three different values that usually appear in a valuation report: First, cost or investment values; second, replacement values; and third, the depreciated values derived from the first two. It is safe to say that if the first two values can be found by accounting methods they will be more accurate than if figured by the engineer. For the cost value there is nothing that can exceed the invoice cost for accuracy and authority, plus, of course, transportation and erection cost. If the invoice is not available, it can often be valued by office records of the cost of similar commodities at a time as near as possible to the date of purchase of the original item. This figure may need to be corrected for any known change in prices between the two dates. If neither of these methods is possible, the question reverts to one of an engineering estimate of the cost of building and selling such a machine, which is very unsatisfactory. The cost to produce depends on the quantity produced and various other factors which are not likely to be known. Furthermore the selling price of an article is controlled by other factors than shop cost. It will be seen, therefore, that here is a case that should be handled by engineering methods only as a last resort.

The replacement or basis for insurable value is the next item. This is also valuable information for those companies whose system of accounting includes a reserve for depreciation, or sinking fund for replacements. This value represents what a similar article would cost new at the time of appraisal, but it usually happens that in ten years or more such articles have been improved upon. The same company may make them, but with such improvements as make them more expensive. The question now arises, should the replacement value be the estimated cost of a similar article as if it were a commercial product, or the actual cost of the nearest similar article now made to do the same work? In practice this is largely an academic question, or at least one to be settled as a matter of expediency, but it may be said that whatever light is shed on the problem will be furnished by the engineer. He is the one who must pass on the suitability of available equipment, or furnish an estimate of the present theoretical replacement cost of a duplicate article.

It is only when such commodities are in the nature of standard equipment that the foregoing methods are applicable. That is, the value of a lathe, either cost or replacement, may be so determined if it is of standard construction, but if it be a special-purpose machine built to order, or, as is commonly found in machine shops, special jigs and tools, these are to be handled only by the engineer, and he will find few problems of valuation that are more difficult to handle.

Depreciation from these values to determine the present remaining value, or the theoretical replacement value allowing for wear, etc., is the most difficult part of appraisal and is distinctly an engineer's problem, whatever other sciences, trades or professions he may draw on for assistance.

Depreciation is either a process that can be detected by the senses, or it is something that experience has shown exists, even if we can detect no sign of its progress. The odor of a hot bearing, the sound of worn gearing or their inspection by sight, touch, or measurement, are practical demonstrations of depreciation. Any or all of these may not establish its exact extent or percentage, but they at least are palpable evidence of it. There is also the depreciation due to chemical or molecular change such as crystallization of an axle, or the burning out of an incandescent-light bulb. Any examination not involving the destruction of the article itself would show no indication of impending failure, even though it were to fail within the next hour. The depreciation of a lead pencil can be established definitely. It is a definite length when new. It is discarded at another reasonable definite length. It can be measured at any time, and the percentage of remaining available service established, which it will be noted is something altogether different from predicting how much longer the owner will use it. The one is a statement of present facts, the other is an attempt to use this information in an attempt to read the future, something that is often necessary, but always dangerous. On the other hand, it is in general a waste of time to attempt by inspection to establish definitely the present condition of an electric motor. It may run without mishap for years, or it may burn out within the next five minutes. No inspection that it is practical to make for valuation purposes could predict either case, nor could the most careful laboratory tests determine when it would next be subjected to an overload beyond its capacity.

The causes of depreciation such as wear, obsolescence, inadequacy, etc., have been enumerated too often to require it here, but in addition to these there are various intangible factors that often overbalance all others. For example, if a shop superintendent believes that a certain machine is obsolete, so far as his shop is concerned, it *is* obsolete, notwithstanding the fact that another man might think otherwise; and the fact that it is obsolete is due to the decision of the man who ordered it scrapped, rather than to anything inherent in the machine. With tangible causes of depreciation the difficulty is not in recognizing them but in measuring their effect in dollars. Wear is easily detected, or measured if need be, but how will you translate thousandths of an inch of wear into dollars of depreciation? With standard types of familiar machines, such as engines, pumps, lathes, motors, etc., the degree of obsolescence or inadequacy may be easy to determine, but in the case of special machinery such as automatic bottle-blowing machinery, looms for wire fencing, or automatic machinery for watch parts, the results of inspection may not be very fruitful. Mechanical engineering is divided and subdivided so often, with a different kind of fruit at the end of each branch, that no one man can be expected to be an authority on all of them. With these problems it is a question of knowing where to find the right information, and being able to get it.

There is one fundamental difference between engineering and accounting appraisals that has been previously hinted at. An engineer standing in front of a machine says, in effect, "This machine, now, today, has 75 per cent of its original value left. I do not care how old it is, or whether the repairs will be kept up in the future. It is in good running condition now, the superintendent is satisfied that even if it is not the very best design for his purpose, it is well up in the list, and without attempting to predict anything that may happen to it in the future, I make my report all in the present tense." If called on to justify his figures, he can point to the satisfactory operation of the machine both as to quality and quantity, and the superintendent can qualify as an expert on that type of machinery. The accountant's report is: "This machine is 10 years old, general practice and various authorities give 20 as the average life of machinery. The remaining life and value is therefore 50 per cent of the original cost. I am not in a position to consider whether or not unusual and extraordinary repairs have been made, or what the plans of the operating force may be with regard to it. I work on the law of averages. If I am not strictly accurate in this particular instance, the accuracy of the total results is not necessarily impaired." The original source of his justification will be found somewhere in a book.

If a considerable volume of statistics were available on the actual active life of different kinds of machinery, extending over a period of at least 30 years, it would be possible to secure a true average life, either of any one kind of machinery, or of machinery as a whole. But no such records exist. Even this is not enough. What is desired in appraisal is a valuation of the particular property under consideration, with consideration for its individual characteristics, and not a cross-section of the average experience of machinery users. The more specialized the nature or conduct of

the business, the greater the error in that particular case. The following report made by an engineer on the valuation of the machinery in such a plant is offered as an example:

July 14, 1920.

It will be noted that numerous machinery items have been depreciated comparatively little, considering their nominal age. The reason for this is as follows:

In Departments A and B the machinery is all of a highly special nature, a major percentage having been either made or materially improved in your own shops and no equally productive machines can be purchased elsewhere. Concrete evidence of these repairs and improvements will be found in the 452 patterns—made for improvements alone—now segregated in Building No. 14.

In general, the manufacturer is able to purchase his machines in the open market, and for this reason does not find it necessary or even advisable to make extensive repairs, but in this instance this does not hold. In case of fire or other total loss, a large part of this special machinery would necessarily be built in their own shops, and the remaining part would require extensive changes to give them a productive value equal to the present equipment.

As a result of these conditions, it has been the persistent policy of the company to give unusual care and attention to repairs. The plant is closed for one week each year, and advantage is taken of this to make repairs that would otherwise be neglected.

In Department C the splitting and shaving machines are simple in construction and have easily renewable parts, consequently the maintenance expense is comparatively small. On the other hand, the cost for repairs in the Weaving Department is a heavy item. Notwithstanding this, however, these machines have been maintained in good condition. For example, three looms which originally cost less than $700 each were repaired and improved in 1908 at a cost of $1830 each (See Journal No. 2, p. 54).

The fact that no better machines are known to exist indicates that there is no depreciation for obsolescence. The fact that repairs are of an unusually extensive nature, indicates that depreciation for wear is correspondingly unusual. The result of these two factors is that the depreciation of these machines is unusually small.

This report indicates the necessity for a thorough investigation of both mechanical and industrial conditions in the plant under consideration, and for this sort of work there is no one better fitted than the engineer. The broader his industrial experience, the better he is fitted for the task. Engineering *methods* are not enough, engineering personnel in the field staff is vitally necessary. Satisfactory results from any method or process presuppose the use of the indicated materials.

Columbus, Ohio. L. L. THWING.

Concerning Honorary Membership

TO THE EDITOR:

Members of about twenty years' standing who remember the old brownstone club house in which the mechanicians of twenty years ago used to gather, will find the new order and new ideals as set forth by our engineering prophets Mr. Cooke, Mr. Hoover, et al., most inspiring.

But as the boys say, the young "grad." this June will be asking, "How do you get that way?"

May it not be summed up in words of one syllable for them once for all by one who has been a "prof.:"—To be a good engineer, "an exceptional man," be something else, or something else also.

Be a portrait painter like Robert Fulton, a polar bear hunter and north pole hunter like dear old Melville, engineer of the universe like dear old Uncle John Brashear, or an engineer of humanity and capitalist like dear old Doctor Andrew Carnegie, and become an Honorary Member like these.

The universe being a mechanical phenomenon, it don't make any difference what you do well—you are a successful mechanical engineer, even if you don't know it till you are elected, like Mr. Charles M. Schwab, Honorary Member.

This is as it should be, and agrees with the conclusions of laborious investigations of the Society for the Promotion of Engineering Education, which I understand were:

1 That engineering education didn't need any promotion, it was just a natural phenomenon going on of itself;

2 That the less technical details a man learned or the more he forgot, the sooner he came into harmony with this natural phenomenon and became a good engineer and material for honorary membership.

When this inspiring process is carried to its logical conclusion as outlined by Mr. H. G. Wells and other engineers, we shall all be Honorary Members and the Society, having outlived its usefulness, will be rewarded accordingly. Meanwhile, let's be "on our way."

Arcadia, Los Angeles, Cal. DAVID H. RAY, Sc.D., Mem. Am.Soc.M.E.

The Question of Entropy

TO THE EDITOR:

In the June issue of MECHANICAL ENGINEERING I find an article by Prof. G. A. Goodenough relative to a criticism made of American steam tables in a review of Professor Callender's tables contained in London *Engineering*. The particular statement objected to is—"the elaborate tables compiled in America . . . . . fail to satisfy the test . . . that the work done in a given cycle should be the same whether measured on the temperature-entropy chart or on the indicator diagram."

In respect to this matter, I beg the privilege of submitting that the criticism made is apparently, but only apparently, sound. I have spent the last six years in a complete restudy of heat and allied subjects, developing new vapor equations, etc., which, while attacking the problem from an entirely new viewpoint, show that the truth lies almost exactly between the values given in Goodenough's steam tables and those given in the Marks and Davis tables, while the work of Keyes and Bromlee on ammonia at the Massachusetts Institute of Technology is, for accuracy, probably the most remarkable piece of experimental work ever accomplished anywhere in the world.

That there is an inconsistency between the temperature-entropy and pressure-volume diagrams is due to an entirely different matter that happens to be to the credit and not to the discredit of these tables for the reason that entropy is *a complete error*. To substantiate this statement I submit (*a*) a mathematical proof, (*b*) a physical proof, and (*c*) its probable original derivation, as follows:

(*a*) Assume that entropy is true to begin with. By definition—

$$dN = \frac{dH}{E}$$

where N is the entropy, H the heat energy, and E the absolute temperature. Since entropy is a function of H and E, we may write—

$$N = f(H,E)$$

Differentiating this equation gives—

$$dN = \left(\frac{dN}{dH}\right)_E dH + \left(\frac{dN}{dE}\right)_H dE$$

the parts in the parentheses being the usual partial differentials. We can therefore equate the two values of dN, getting—

$$\frac{dH}{E} = \left(\frac{dN}{dH}\right)_H dH + \left(\frac{dN}{dE}\right)_H dE$$

This equation is satisfied only when—

$$\left(\frac{dN}{dE}\right)_H = 0$$

and therefore E = a constant. That is, entropy is an error except when the temperature is constant.

(*b*) Assume again that entropy is true. We have then that

$$H = \int E dN$$

Let us now have reference to the temperature-entropy diagram shown in Fig. 1. Suppose a substance is originally under the conditions indicated by the point 1 and that its thermal conditions are changed until they are as indicated by the point 2. According to the equation $DH = EdN$ the heat added will equal the area under the path by which the thermal conditions are changed from the conditions 1 to the conditions 2. If, for example, the path of change is 1*A*2, the heat added, according to this equation, will be the area under the curve 1*A*2. If it is changed by the path 1*B*2, the heat added will equal the area under the curve 1*B*2; and similarly for the curve 1*C*2, or any other conceivable curve. According to the equation $dH = EdN$ the heat content of a substance for any given conditions (E,N) is infinitely many-valued. As a matter of fact, the heat content of a substance depends only upon its final conditions and not at all upon the path by which these final conditions were arrived at. A pound of dry saturated steam

has a certain heat content when at, say, a pressure of 100 lb., irrespective of how this steam was produced, whether by heating up a liquid, or cooling down from the superheated state, or any other way. The conclusion is therefore enforced that the equation $dH = EdN$ is not true.

(c) The calculus teaches that the area A under a given curve $y = f(x)$ is—

$$dA = ydx$$

We thus have two simultaneous equations, namely,

$$y = f(x) \text{ and } y = dA/dx$$

Letting

$$y = E,\ A = H, \text{ and } x = N$$

then

$$E = dH/dN$$

or
$$dN = \frac{dH}{E} \quad \ldots\ldots [1]$$

and
$$E = f(N) \quad \ldots\ldots [2]$$

Equation [1] is meaningless without Equation [2], for what can be the area under a curve when there is no curve?

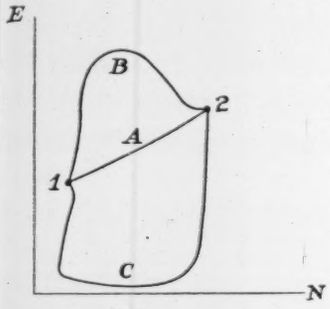


Fig. 1

I think that heat engineering will be greatly benefited by getting away from this age-old error. I know that it has proved so in my case.

O. B. Goldman.

Portland, Ore.

U. S. Patent Office Relief

To the Editor:

I note your article in the July number of Mechanical Engineering on U. S. Patent Office Relief, and wish to say that too much publicity cannot be given to Patent Office conditions.

In my opinion the Patent Office stands at the very foundation of industrial welfare and progress. Great industries are founded on patent rights; they either could not have been founded at all or would have been greatly delayed if the inducement of a limited period of enjoyment of the fruits of the invention had not been given. Mechanics and students of the sciences are constantly striving to accomplish great inventions, and in many cases their sole incentive is a patent whereby their fortunes may be assured. I doubt if there is a single engineer of any standing who has neither secured nor applied for a patent.

Consequently the administration of the Patent Office is of great moment to both engineers and manufacturers, whose success often depends on valid patent rights. It is desirable that applications receive prompt action, but above all things such action should be the result of a careful search by competent examiners.

At the present time neither of these requisites can be fulfilled by the Patent Office, because there is a shortage of examiners and this shortage exists principally among the older, more skillful examiners, who are daily being lured away from the Office by higher salaries. At the present time I have applications pending in mechanical engineering classes that were filed nine months ago, and on which I have received no action. About one-third of the applications filed are not acted on for six months or more.

Surely this situation would be remedied if brought forcibly to the attention of the representatives in Congress.

Engineers, inventors, manufacturers: write your representative to vote for the Lampert Bill.

St. Louis, Mo. H. A. Baimes.

The Banki Hydraulic Turbine

To the Editor:

The May issue of Mechanical Engineering on page 345 gives particulars regarding a "new" hydraulic turbine, the invention of Professor Banki of Budapest. This development has been given considerable publicity, but engineers and manufacturers of hydraulic turbines have been practically unanimous in agreeing that the design does not incorporate those features of efficiency, reliability and reduction of first cost which are the fundamental requirements in modern turbines.

The turbine in question is very close in its major characteristics to the Girard type of turbine in use twenty or thirty years ago, but since discarded. This type of turbine has not been built in any appreciable quantity for the last fifteen years and is not in any way a factor in modern development because it possesses numerous operating disadvantages in connection with pitting of the blades and nozzles, low efficiency, and uneconomical arrangement. These comments apply to the Girard type of turbine arranged with a single application of the jet. All of the disadvantages would be greatly increased in the attempt to pass the jet through the wheel a second time. As a matter of fact, it is not conceivable that a jet, having passed a set of buckets, should remain in a state capable of developing additional power at desirable efficiency.

The inventor of the turbine under consideration fixes the diameter of the wheel at $D = 72.86\sqrt{(H)}/n$. In terms of peripheral coefficient this formula means that the rim runs at a speed equal to $0.48\sqrt{(2gH)}$. This peripheral coefficient of 0.48 is the same as is used on standard impulse wheels, so from that standpoint there is practically no advantage in the type proposed. While it is possible to use a smaller diameter and consequently higher r.p.m. and maintain this same coefficient, the most extreme proposition that could be secured is far below that easily obtained with the Francis type of runner, which has a peripheral coefficient of 0.6 to 0.7 for the heads to which the proposed wheel is apparently adapted. Furthermore the Francis turbine can be reduced in diameter to a much greater extent than can the proposed Banki wheel in the effort to secure higher speeds. There might be an advantage in the Banki wheel in connection with the width of opening between buckets, this being an advantage as regards clogging on smaller-sized wheels, but the other mechanical disadvantages of the Banki arrangement, particularly in connection with arrangement of nozzle, far outweigh this single point.

In addition to amplifying the features which caused the Girard turbine to be a commercial failure, this type of wheel possesses the inherent disadvantage of an impulse wheel, that is, it must be set above tail-water level so that with the medium-head field, which alone is open to this type of development, there is a prohibitive percentage of loss due to its application.

From a theoretical hydraulic standpoint there is considerable justification for some of the contentions made. From a standpoint of practical hydraulic engineering there is no advantage. Mechanically the wheel can hardly be arranged to permit of the use of a needle type of nozzle, which alone has stood the test of time in the development of the impulse type of turbine.

F. Nagler.

Milwaukee, Wis.

Engineering Schools

To the Editor:

On page 420 of the June issue of Mechanical Engineering, Dean Bishop is quoted as saying "There is no first-class engineering school to be found in America." Taken by itself as printed and with no explanation of the word "first-class" it is a surprisingly frank statement, but I fear it may tend to compromise our engineering education in the eyes of some who may think it is really true. In the words of Dr. Adams, who supported the charge, it "neglects most of the variables." Probably the speaker desired simply to "start something" in the same way as did Edison with his questions for the college men.

Your report of discussion includes the following comments by Dr. Comfort A. Adams:

In support of the last and rather startling statements made by Dean Bishop the chairman said that he would guarantee to take the graduates in electrical engineering from any institution in this country and prove in a

five-minute oral examination of each one, in 98 or 99 per cent of the cases, that the men do not understand in any thorough fashion the fundamentals of the subject; that in most cases they do not even know the meaning of the words they use; that they are carried through analyses of comparatively complicated problems, but in a machine-like superficial way, neglecting most of the variables, so that they get into the habit of a kind of loose thinking which so affects all their work that they cannot be counted on for any sound results.

Does not Dr. Adams miss the point? The highest aim of the teacher is to direct the student to think for himself, rather than to carry him through "comparatively complicated problems in a machine-like, superficial way." The good teacher has that higher aim constantly in mind. Measure up your graduate by that as well as by the test mentioned by Dr. Adams and see if 98 or 99 per cent of the graduates will fall down. If over 90 per cent do fall, then you may more safely conclude there is no first-class engineering school in the country; but don't place the charge solely upon the depth of abstract knowledge which a man ten years out of college in responsible work would also fall down on if put to the same test.

True, we need more than ever a larger number of first-class engineering schools, but more than that we need a greater stress laid on the fundamentals in all the engineering schools of the country. Measure the standard on the basis of ability to think clearly rather than solely on the ground of a multitude of accumulated facts. We need to cultivate the engineering type of mind, and that calls for elements of character as well as elements of knowledge.

State College, Pa. ARTHUR J. WOOD.

Progress Report on Symbols in Heat Engineering

Preliminary Report of The American Society of Mechanical Engineers' Standing Committee on Technical Nomenclature

SINCE July 1917 The American Society of Mechanical Engineers has had a committee cooperating with a similar committee of the Society for the Promotion of Engineering Education for the purpose of systematizing and standardizing technical nomenclature. Recently this committee was made a standing committee of the Society and for the past year or more it has devoted its attention to the subject of heat engineering.

The report which appears below is of a preliminary nature and is printed here to elicit general discussion by those interested in this phase of the subject.

The Chairman of the Committee is Mr. W. D. Ennis, and he may be addressed in care of The American Society of Mechanical Engineers, 29 West 39th Street, New York City.

THE PRELIMINARY REPORT

1 The concepts or quantities relating to a liquid, its saturated or its superheated vapor for which symbols are most commonly used are:

Heat content
Temperature
Pressure
Volume
Entropy.

In addition, the following quantities are commonly symbolized:

Specific heat of superheated vapor at constant pressure
Mechanical equivalent of heat (778)
Dryness (saturated vapor)
Latent heat of vaporization (rarely that of fusion)
Entropy of vaporization
Internal and external portions of the latent heat of vaporization
Ratio of specific heats of gases
Specific heats at constant pressure and at constant volume (gases).

Less commonly used symbols are those for—

Reciprocal of the mechanical equivalent of heat density
Absolute temperature

2 As the result of a few preliminary letters and some oral discussion, the following principles seem to command rather general (though not universal) assent:

(*a*) Greek letters should be avoided.

(*b*) Dimensional symbolism should not be attempted.

3 The standardization most needed is that which relates to symbols for properties of liquids and their vapors—particularly water. There are three physical conditions to be distinguished: liquid, saturated vapor (wet or dry), and superheated vapor. It is natural to use small and capital letters for two of these conditions: as h, H; t, T; v, V; n, N; for liquid and saturated vapor. The third condition must then be designated (unless by a different letter) by either a prime or a subscript.

Primes are not likely to be confused with exponents, because the latter are rarely used in heat engineering. The chief objection to them is one of typography—they are apt to break off or slip out.

Subscripts are objectionable because they are also needed to refer to stated points. Thus if N_1 denotes entropy of superheated steam, we might have to write $(N_1)_a$ and $(N_1)_b$. Both are awkward forms and do not sound when enunciated verbally.

4 Absolute temperature could be designated by $t + 460$, $T + 460$, etc., and no special symbol is imperatively necessary, although many writers use t for fahrenheit and T for absolute.

5 Present usage seems to indicate maximum popularity for the following:

Cp, J, p, t, h, L or r, H, v
(with primes or subscripts)

For other quantities there is no uniformity of symbolism.

By using the following, there would be no departure from generally accepted usage:

Heat content	h, H, H'	
Temperature	$(t = T)$ T'	
Pressure	p	
Volume	v, V, V'	
Entropy	n, N, N'	(It is true that
Mechanical equivalent of heat	J	n is often used
Its reciprocal	A	as the polytropic exponent)
Dryness	x or q	(preferably the latter)
Latent heat of vaporization	$L = H - h$	
Entropy of vaporization	$N - n$	(no single symbol.) See Note.
Internal latent heat	r	(implies the use of L for total latent heat)
Ratio of specific heats	y	(suggests a former Greek symbol)
Specific heat at constant pressure	C_p	
Specific heat at constant volume	C_v	

NOTE:—There is perhaps a real need for a single symbol. The entropy of a wet vapor would be—

$$n + q(N - n) = qN + n(1 - q)$$

If for $(N - n)$ we had a single symbol, l (though this might be useful for latent heat of fusion) there would result the simpler form—

$$n + ql$$

Tests carried out on paint-spraying machines have shown, according to the *Architect*, that spraying requires approximately 10 per cent more paint than brushing when the surface being treated is an iron roof, while brushing requires approximately 200 per cent more labor than spraying. On exterior brick walls spraying requires 7 per cent more paint than brushing, while brushing requires 109 per cent more labor than spraying. On interior ceilings and walls of plaster spraying requires 40 per cent more paint than brushing but gives a better hiding in one coat. On similar work brushing requires 160 per cent more labor than spraying, and gives a poorer hiding in one coat. Although it has not been possible as yet to arrive at a definite conclusion confirming the relative durability of spraying as compared with hand painting, it is claimed that the investigations so far made tend to support the belief that the spraying work will last longer.—*The Engineer* (London), July 25, 1921.

MECHANICAL ENGINEERING

A Monthly Journal Containing a Review of Progress and Attainments in Mechanical Engineering and Related Fields, The Engineering Index (of current engineering literature), together with a Summary of the Activities, Papers and Proceedings of

The American Society of Mechanical Engineers

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C 55 The Society as a body is not responsible for the statements of facts or opinions advanced in papers or discussions.

What the Virginia Capes Aircraft Bombing Tests Show

THE conflict between the air bombing squadron and the ex-German battleship *Ostfriesland* off the Virginia Capes was an epoch-making incident in the ever-present conflict between the old and well-established and the new and untried. The new device proved successful and indicated a future.

ELMER A. SPERRY

When the United States entered the world war in 1917 it did not possess a single military flying machine, and of the two score training planes then owned by the Army and Navy there were barely a baker's dozen capable of an hour's flight. Not quite four years have elapsed between the foundation of American military aeronautics and the sending out of the unprotected David of the air with a few bombs to do battle with the Goliath of the sea protected with armament representing forty years of sustained development costing billions of dollars. The battleship went to the bottom of the ocean in less than twenty-five minutes. Still the aircraft engineers responsible for this remarkable performance thoroughly realize the crudeness of the airplane, especially as regards the sighting, aiming and bomb-dropping devices.

The battleship can be made larger and faster, but this will not make it less vulnerable to aerial attack. The airplane, however, is only at the threshold of its development. The question seems to be one of time when the battleship will be driven from the sea.

American engineers have particular reasons to glory in the success of our flyers. The planes used were chiefly of American design, driven by a typical American motor. The bold conception of the test was on a par with the big things done every day by our engineers, and the daring of the men who flew for over a hundred miles out to sea in planes which had no facilities for landing on the water is something of which the nation may well feel proud.

Great honor must be given to the persistent and marvelous organization of the Air Service, which carried this difficult task to such successful completion. This is due in large measure to the enthusiasm and leadership of General Mitchell and his extremely able corps of assistants. Colonel Bane, chief of the Engineering Division of the Air Service, is another who should receive no small amount of praise and congratulations.

From my experience in connection with the production of the first depth bomb for the Navy, I am convinced that it is the only device capable of reaching the vulnerable parts of a battleship. The enormous sledge-hammer blow that is delivered to the ship's structure by a depth bomb at a distance is something prodigious. The compressibility of water being only 1/150 at the pressure of one ton per square inch, it acts to all intents and purposes as a perfect solid in transmitting the enormous concussion. Mass action is the secret of the success of the depth bomb, as is shown in the following formula:

$$P = \frac{0.68\,WK}{D^{1.39}}$$

where P is the effective pressure in tons per square inch against the target from the depth bomb; D the distance from the center of the charge to the face of the target, in feet; K the coefficient, which for the TNT equals 3.17; and W the weight of the charge in pounds.

In early bombing days, from the heights to which anti-aircraft guns drove the aircraft it was lucky if the bomb was able to hit the township containing the target. The precision obtained since that time in the various elements of the bombing equipment is due in no small measure to the astute, practical mathematician, the man who is 100 per cent mathematician and also 100 per cent engineer, in being able to point out a practical and physical, as well as simple, solution of otherwise very perplexing and abstruse formulas. This, together with the new method of stabilizing, finding and being able to hold the exact vertical reference line, and precision flight due to great care on the part of the pilot, are all important elements, but in the last analysis the level head and horse sense of the "man behind the gun" constitute no small part of the answer.

So aircraft, which is the natural American heritage, is coming not only into its own, but assuming nothing short of sovereign leadership in direct offensive action, and it has remained for America again to lead the way.

There are many defensive actions in which aeronautics will from now on take prominent leadership, and all are based on the most highly organized engineering analysis and skill. I therefore recommend that our Aeronautic Division make a close study of these intensely interesting activities so as to be in readiness to extend first aid in this all-important development.

ELMER A. SPERRY.

The Value of the Waste Report

THE report o fthe Committee of The Federated American Engineering Societies on the Elimination of Waste in Industry, an abstract of which we publish elsewhere in this issue, has recently been released.

Some criticism of it has appeared, based evidently upon too brief and incomplete extracts from it. In the main, however, comment upon the report has been intelligent and appreciative, and we believe will be more so as the complete report is studied and understood.

The carefully prepared "Questionnaire" used by the field workers for the committee has been declared by some of the shrewdest and most progressive manufacturers to be in itself a valuable thing that ought to be meditated upon by every one in any way responsible for the conduct of industrial operations.

The report shows that the opportunity of management for improving industrial affairs is much larger than that of "labor," and upon this point the report sustains the opinion of practically all trained observers who have studied the matter, including many industrial managers and proprietors of manufacturing establishments themselves.

The real value of the Waste Report will be determined by its success as a stimulant to future waste-eliminating activity.

In the industry of this country there are a great many variables, the evaluation of which, to permit comparison between plants or

divisions in the same industry or between the various industries, cannot but lead to greater or less differences of opinion about the findings of any group of men. The report, however, definitely points out wastes and recommends steps for their elimination. This last is the work of years, calling for the concentrated, coöperative effort of every individual and organization interested in industrial administration and development. This effort should not be dissipated in combating statements in the report that happen not to please. Wastes must be eliminated, not argued away, if the industries of America are to stand the test of the future. As the product of capable, conscientious men, realizing the tremendous importance of the subject, this report deserves more than criticism of details, especially since its great mission is that of a call to service in waste elimination.

Admittedly preliminary in character, the Waste Report sheds enough light on the situation to show the way of future waste-elimination procedure.

The American Society of Mechanical Engineers is taking the lead, and the 1921 Annual Meeting will be devoted to the subject of Elimination of Waste in Industry. Although the program has been prepared without definite relation to the Waste Report, the various Professional Divisions will present definite technical contributions to waste elimination in their various fields. The following subjects indicate the character of the meeting: Power-Plant Heat Balance as a Factor in Economic Operations; Avoidable Losses in Locomotives; Waste in Small Machine Shops; Hidden Wastes in Textile Mills; Importance of Research in Waste Elimination; and Development in Boiler and Furnace Design as a Factor in Reducing Fuel Waste. The presentation and discussion of these papers on that occasion will constitute a strong attack against waste.

This meeting will be but a step forward, however, and great strides are necessary. The report should be studied carefully by every industrial and business leader so that the results of this intensive study may be put to work at once in every industrial establishment where there is the desire to advance the economy and industrial technique of the country. Furthermore, general familiarity with the Waste Report should stimulate thought and action toward the development of an aggressive program for waste elimination.

The DeLamater Ericsson Tablet Committee

March 9, 1922, will be the sixtieth anniversary of the battle of the *Monitor* and *Merrimac* at Hampton Roads, Va., which demonstrated the merits of the turreted battleship. That has been the date selected by the DeLamater Ericsson Tablet Committee to memorialize the services of Mr. Cornelius H. DeLamater and Capt. John Ericsson, who for 50 years, 1839–1889, were pioneers in developing the naval, marine and industrial interests of this country, and who at the time of the civil war, without thought of personal reward, turned their mental and financial resources to account and applied their knowledge and experience to accomplish what the Government had failed to do.

The Government has appropriated $35,000, and private individuals have subscribed a larger sum for a memorial to Captain Ericsson in Washington adjacent to the Lincoln Memorial, and $5000 is being raised by private subscription among engineering and marine interests to erect bronze tablets on four sites of buildings in New York City with which the lives and work of the two men were identified.

These are (1) The Phoenix Foundry, 260 West Street, between Laight and Vestry Streets, where the first iron boats in this country were built and the screw propeller was first introduced on river and ocean steamers. Some of the equipment of the *Princeton*, the first battleship with machinery and boilers below the water line safe from cannon shot, was constructed there, revolutionizing the navies of the world. The 3-in. pipe for the Croton Aqueduct and hot-air engines to pump the Croton water to the upper floors of houses were conceived and built there, as well as much other notable work. (2) The DeLamater Iron Works, foot of West 13th Street, where many industries now internationally established obtained their first development. There the first self-propelled torpedo, the first torpedo boat, the first submarine boat, and the engines for the original *Monitor*, were built, and the *Dictator* was built complete. (3) The Continental Iron Works, Greenpoint, Brooklyn, L. I., where the hull of the original *Monitor* was built and the *Puritan* and other monitors were built complete; and (4) No. 36 Beach Street, where Captain Ericsson lived and worked and died. By the *Monitor*, the navies of the world were revolutionized a second time.

The movement to erect these tablets started at the DeLamater Ericsson Commemoration meeting held December 3, 1919, in the auditorium of the Engineering Societies Building, 29 West 39th Street, in which the following twelve engineering and civic organizations participated: The American Scandinavian Alliance of Greater New York; American Scandinavian Foundation; American Scenic and Historic Preservation Society; The American Society of Mechanical Engineers; American Society of Naval Architects and Marine Engineers; American Society of Refrigerating Engineers; American Society of Swedish Engineers; Associated Veterans of the DeLamater Iron Works; Engineers' Club of New York; General Society of Mechanics and Tradesmen; John Ericsson Memorial Committee; New York Historical Society; and The Union League Club.

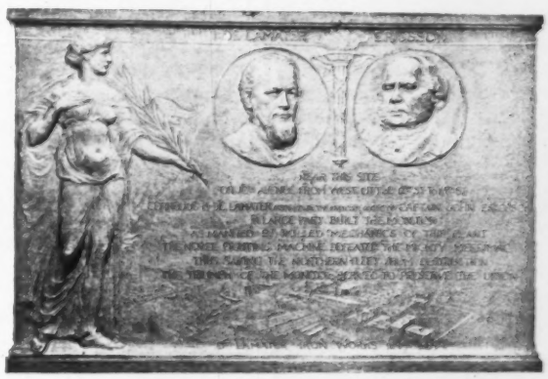


TABLE TO MARK SITE OF DELAMATER IRON WORKS

Since then the following additional societies have joined the movement; Amaranthus Lodge, I.O.O.F.; Bredablick Lodge, F. & A.M.; Captain John Ericsson Memorial Society of Swedish Engineers; Engineers' Club of Trenton, N. J.; Past District Grand Masters Association; and the United Swedish Societies of New York. A number of prominent marine interests and private individuals have subscribed to the Tablet Fund.

Mr. Isidore Konti is the sculptor, the Municipal Art Commission has accepted the design and the American Scenic and Historic Preservation Society will serve as guardian of the tablets.

The Committee proposes to unveil the tablets in the afternoon of March 9 and in the evening to hold a public dinner meeting at one of the large hotels, at which representatives of the Swedish and United States federal, state and municipal governments, as well as of prominent marine and industrial interests, will be present and speak. The children attending the various public schools located near the localities of the tablet sites will participate in the ceremonies.

The Committee would like to hear from other technical societies, civic organizations, marine and industrial interests and individuals who desire to show their patriotism and appreciation of the services to the country of Mr. DeLamater and Captain Eriesson by participating in this movement. Any money left after the tablets are erected will be devoted to the establishment of a depository for relics and memorabilia of Captain Ericsson, of which there are already considerable in hand. Correspondence should be addressed to The DeLamater Ericsson Tablet Committee, Engineering Societies Building, 29 West 39th St., New York, N. Y. This Committee consists of H. F. J. Porter, *Chairman*, Oakley R. De Lamater, Frederick A. Halsey, Axel S. Hedman, Ernst Ohnell, Henry R. Towne, and Charles Vezin.

Death of Dr. George F. Blessing

George F. Blessing

Dr. George Frederick Blessing, professor of engineering at Swarthmore College, passed away at his summer home at Bay View, Mich., June 24, after a brief illness. He was born in Carrollton, Ky., in 1875, and was a graduate of Kentucky University and also of Hanover College, Ind., from which he received the degree of Ph.D. in 1908. After graduation, Professor Blessing spent several years in practical work, becoming professor of mechanical engineering at the University of Nevada in 1899, where he stayed till 1905, spending his summers in practical work with various concerns on the Pacific Coast. In 1905 he became connected with the General Electric Company at their Lynn works as a designer in the steam-turbine department, and in 1906 he became assistant professor of machine design at Cornell University. In 1908 he accepted the position at Swarthmore which he held at his death.

Professor Blessing was essentially a great teacher. Gifted with a brilliant mind, he also possessed the interest in his fellow-beings so essential to the successful teacher. At the time of his death he was employing a leave of absence from university work in making an investigation of industrial conditions for Mr. John D. Rockefeller, Jr., in the mines and mills of the Colorado Fuel and Iron Company in Colorado, and in endeavoring to develop new ideas in this work. The result of this work and similar previous experiences was to have been published in book form and it is hoped that the large amount of material gathered can be edited and published in the near future, as such a volume would undoubtely prove of great value to students of industrial conditions. Overexertion incident to this work brought on a physical breakdown from which he failed to rally, and his illness was of short duration.

Professor Blessing was the author of books on machine drawing and descriptive geometry and of various contributions to the technical press. He was a member of The American Society of Mechanical Engineers, the Society for the Promotion of Engineering Education, the Efficiency Society, the Engineers' Club of Philadelphia, and the honorary scientific societies of Sigma Xi and Tau Beta Pi.

In his death the Society and the teaching profession lose an able engineer, a fine teacher, and a man of sterling qualities and of lovable character. His untimely end will be deeply regretted by a host of friends and former students throughout the entire country. Few men possess the attractive personal qualities that endeared him to a very large circle of acquaintances.

Conference to Stabilize Road Building

Herbert Hoover, Secretary of Commerce, called a conference of engineers and state highway officials on July 18 in Washington. The purpose of the conference was to obtain engineering suggestions and criticisms on the advisability of awarding highway contracts in the fall for the next season's work. This would stimulate the buying of materials and equipment early enough to give a stable period for the manufacture and shipment of such materials and would also enable the contractor to plan in the winter for his work in the coming year and to devote all of his time and efforts to the construction of roads in the favorable part of the summer. The following men attended the conference: Col. W. D. Uhler, chief engineer, State Highway Department, Pennsylvania, representing Civil Engineers; Mr. Coleman, chief engineer, Highway Department, State of Virginia, representing Association of State Highway Officials; Mr. Upham, chief engineer, State Highway Department, North Carolina, representing, the State Highway Officials; Gen. R. C. Marshall, Jr., general manager, Association of General Contractors; Prof. W. K. Hatt, representing National Research Council; Thomas MacDonald, chief, Bureau of Public Roads, Department of Agriculture; L. W. Wallace, executive secretary, American Engineering Council; and R. M. Gates, representing The American Society of Mechanical Engineers.

The conference prepared and presented a report in which were pointed out the engineering advantages of fall awarding of highway contracts, namely, a much longer construction season and a consequent better service in the handling of highway construction materials; less fluctuation in construction and a greater possibility of completion of highway programs. This system would permit interseasonal work with resulting increase in the continuous employment of labor, more uniform production in basic industries, and more efficient road-building organizations.

The conference did not substantiate the assumption that the cost of road-making materials is generally high in the fall. From the report of the conference Secretary Hoover prepared a memorandum for the governor of each of the states, which he forwarded to them with the earnest request that the matter be given careful consideration in view of the need for economical construction and the stabilization of employment and manufacture of material and equipment.

Highway Research on a National Basis

The Advisory Board on Highway Research which was established by the Division of Engineering of the National Research Council, with the coöperation of Engineering Foundation at a conference held in New York last November, has recently engaged William Kendrick Hatt, professor of civil engineering and director of the materials testing laboratory, Purdue University, to direct its work in national highway research.

The purposes of the Advisory Board are:

a To assist existing organizations in outlining a comprehensive national program of highway research and coördinating their activities thereunder

b To organize committees for specific problems

c To act in a general advisory capacity

d To serve as a clearing house for highway research information.

The Advisory Board is composed of fifteen organizations of national importance interested in the design, construction, economics, maintenance and financing of highways, in materials and equipment therefor, and in vehicles used on highways; governmental departments and bureaus of similar interests, and higher educational institutions. In addition to the member organizations, which include The American Society of Mechanical Engineers, thirteen state highway departments and more than forty universities have definitely signified their interest in the work of the Advisory Board and their willingness to coöperate.

Anson Marston, dean of engineering, Iowa State College, and a member of the Iowa State Highway Commission, is chairman of the Board, and Alfred D. Flinn, secretary of Engineering Foundation and vice-chairman of the Division of Engineering of the National Research Council, is vice-chairman.

Three technical committees have been at work for a number of months. These are the committees on Economic Theory of Highway Improvement; on Character and Use of Road Materials; and on Structural Design of Roads. Committees on Vehicle Design as Related to a Road; on Economics and Cost of Transport; on Financing Highway Improvements, on Traffic Studies, and on Organization of Construction Plants are under consideration.

Professor Hatt, in consultation with the Advisory Board, will prepare a comprehensive plan of the field of highway research, including economics, design, construction and administration, and will arrange a program of committee work for those fields that need to be occupied immediately.

N.E.L.A. Issues Reprints of Prime Movers Committee Report

The Prime Movers Committee of the National Electric Light Association presented a comprehensive report at the recent Chicago Meeting of the Association. The functions of the Committee are the investigation and reporting of developments in design, installation, and operation of prime movers and equipment for the production of power from fuel for the generation of electricity.

This report, a book of 350 pages, contains considerable information about the various types of new equipment which have been developed and placed in use. The statements of users and manufacturers are given concerning each class of equipment. A bibliography is also provided for those who wish to get more complete information. The demand proved to be so great that the N.E.L.A. has authorized the reprinting of the report. Copies are on sale at the Association headquarters, 29 West 39th St., New York, N. Y.

News of the Federated American Engineering Societies

September Board Meeting to be Held at Washington

THE next meeting of the Executive Board of the American Engineering Council will be held at the Cosmos Club in Washington on September 30. This will be the first meeting of the Board in Washington since its initial meeting held there November 20, 1920. It is probable that the Board will decide at this meeting whether it will hold future meetings regularly at the Washington headquarters or will pursue the plan of meeting at various engineering centers throughout the country as it has been doing during the past year.

The most important business coming before the September meeting will be the election of a president to succeed Herbert Hoover, who resigned after he became Secretary of Commerce. Nominations to fill this vacancy were ordered at the last meeting of the Executive Board, held at St. Louis on June 3. Other items which have been before the Board will come up for further consideration, special attention being given to the plans for the Engineering Assembly, the extension of the Employment Service, and the question of licensing and registration of engineers.

Employment Service Conducts Special Work

In regard to Employment Service extension the Finance Committee has made arrangements to increase the budget of the Employment Service so that special emergency work can be done for the large number of engineers now out of employment. Prominent engineers, manufacturers and bankers throughout the country will be canvassed by letter for the purpose of compiling information on vacant positions. Special committees of engineers will call on prospective employers as much as possible throughout the states.

In New York City a volunteer committee of twelve has been engaged in this work since late in May. In spite of the fact that the vacation period and changed addresses and business connections have materially delayed the work, a report of this committee submitted on August 15 shows that over 1600 calls have been made 1000 interviews granted, 36 positions found, and 59 prospective positions listed. Practically all of the technical journals, allied journals and periodicals read by engineers and captains of industry have been called upon and a number of editorials have already been published. Slightly over 300 new calls and some return calls remain to be made in New York City proper. A classification of members by companies in the commuting area of the city (outside of Manhattan) is well under way and recommendations may be made on the organizing of one or more committees to cover that area.

The special Employment Committee of the Council is working in conjunction with the Employment Management Committee in developing further plans for the Service.

Engineering Assembly Planned for January

The Engineering Assembly Committee has been appointed as follows:

A. P. DAVIS, Washington, D. C., *Chairman*
PHILIP N. MOORE, St. Louis, Mo.
L. P. ALFORD, New York, N. Y.
JOHN C. HOYT, Washington, D. C.
F. A. VAUGHN, Milwaukee, Wis.

This committee will work out detailed plans for an assembly to be held in conjunction with the annual meeting of the American Engineering Council, the assembly having been authorized by the special vote of the Executive Board at its Philadelphia meeting in April. Present plans are to make this assembly a three-day session during the latter part of January 1922. One day will probably be devoted to special meetings of the Executive Boards of member organizations and committees of the Council, one to sessions of the Council, and one to the discussion of some special topic such as elimination of waste, licensing of engineers, the National Department of Public Works, or some other subject of equal importance to the engineering profession.

Committee Work of Council Varied and Important

The Committee on Procedure and the Committee on Public Affairs have been of great assistance in carrying on the work of the Council. Under their direction the Council has been active in advancing the plans for a National Department of Public Works, improving the status of public health engineers, obtaining equitable engineering research legislation, coöperating with the American Engineering Standards Committee, working for the appointment of engineers to engineering positions in the Federal Government, supporting the topographic mapping program and much-needed patent legislation, etc.

The most important committee work of the Council during recent months has been the study of Elimination of Waste in Industry. An abstract of the report of this committee will be found elsewhere in this issue. Copies of the complete report will be available shortly and may be secured from L. W. Wallace, Secretary of the Federated American Engineering Societies, 719 Fifteenth St., N. W., Washington, D. C.

Engineering and Industrial Standardization

Results of the Last Three Years' Work of the Joint Committee on Steel Roller Chains Shown by Report on Standards Developed

FROM time to time since its organization in July 1917, the Joint Committee of the Society of Automotive Engineers and The American Society of Mechanical Engineers has made progress reports. Now, however, we are able to publish the standards which it has developed for (1) Roller Transmission Chain Dimensions, Heavy, Medium and Light Series; (2) Roller Transmission Chain Sprockets; (3) Tooth Forms for Roller-Chain Sprockets and corresponding cutter design; and (4) Uniform System for Numbering Chains.[1]

As its work has progressed, the Joint Committee has kept constantly in touch with the work of the Association of British Driving Chain Manufacturers with a view to the final adoption of standards which would receive international approval. Consequently certain concessions have been made on both sides and the standard dimensions given below are the same, with a very few exceptions, as those adopted by the A.B.D.C.M.

ROLLER TRANSMISSION CHAINS—HEAVY SERIES

The "chain widths" given in Column 5 of Table 1 are for the wide-chain series. The numbers express the exact distance between the inside plates and are as near to the norm of $W = {}^5/_8 P$ as seems advisable in consideration of present practice and the desire to express dimensions in terms of binary fractions. These are known as "wide" chains.

The Committee also recognizes as standard a narrow class of chains for which $W = 0.41\ P$, but recommends only the wide series for general practice. These narrow chains can be made in all three series, heavy, medium and light.

ROLLER TRANSMISSION CHAINS—MEDIUM SERIES

The standard medium-weight series of roller transmission chains is developed by adopting for each pitch the standard rollers, bush-

[1] Standards (1) and (2) were presented to the A.S.M.E. at the Spring Meeting held in May, 1921, in Chicago and were adopted. Standards (3) and (4) will be presented to this Society for adoption in December, 1921. The S.A.E. has already adopted the entire set.

ings, and pins of the next shorter pitch and assembling them with side plates equal in thickness to those of the next shorter pitch of the heavy series.

Roller Transmission Chains—Light Series

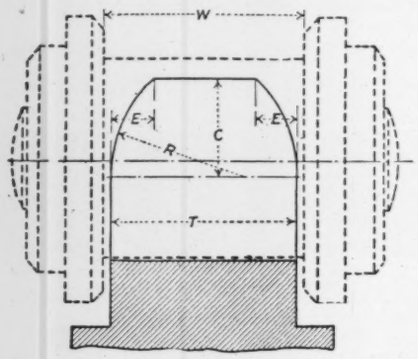
The standard light-weight series of roller transmission chains is developed by adopting for each pitch the standard rollers, bushings, and pins of the second shorter pitch and assembling them with side plates equal in thickness to those of the second shorter pitch of the heavy series.

TABLE 1 DIMENSIONS OF ROLLER TRANSMISSION CHAIN, HEAVY SERIES, IN INCHES

Pitch	Roller Diameter	Pin Diameter	Thickness of Inside Plates	Chain Width, Min. (W[1])	Measuring Load, Lb.	Approx. Test Load, Lb.
3/8	0.250	0.125	0.050	0.250	14	464
1/2	0.3125	0.156	0.060	0.3125	25	825
5/8	0.400	0.200	0.080	0.375	39	1280
3/4	0.469	0.234	0.094	0.500	56	1850
1	0.625	0.3125	0.125	0.625	100	3300
1 1/4	0.750	0.375	0.156	0.750	156	5150
1 1/2	0.875	0.4375	0.1875	1.000	225	7430
1 3/4	1.000	0.500	0.220	1.125	325	10700
2	1.125	0.5625	0.250	1.250	400	13200
2 1/2	1.550	0.781	0.3125	1.5625	625	20600
3	1.900	0.9375	0.375	1.875	900	29700
4	2.500	1.250	0.500	2.500	1600	52800
5	3.000	1.500	0.625	3.000	2500	82500
Formulas	Approx. 5/8 P	Approx. 1/2 roller diam.	1/8 P	Approx. 0.625 P	100 P[2]	Approx. 3300 P[2] or 1/3 breaking strength

[1]See W in illustration of Table 2

TABLE 2 DIMENSIONS OF ROLLER TRANSMISSION CHAIN SPROCKETS



R (Min) = 0.43 P. W = Chain width.

Pitch (P)	Sprocket Width (T)	C	E	Sprocket Bottom Diam. Minus Tolerance	Nominal Clearance (W—T)
3/8	0.227 ±0.004	0.113	3/64	0.004	0.023
1/2	0.284 ±0.005	0.150	1/16	0.006	0.028
5/8	0.343 ±0.006	0.1875	5/64	0.007	0.032
3/4	0.459 ±0.007	0.225	3/32	0.009	0.041
1	0.575 ±0.008	0.300	1/8	0.012	0.050
1 1/4	0.692 ±0.010	0.375	5/32	0.015	0.058
1 1/2	0.924 ±0.012	0.450	3/16	0.018	0.076
1 3/4	1.040 ±0.013	0.525	7/32	0.021	0.085
2	1.156 ±0.015	0.600	1/4	0.024	0.094
2 1/2	1.447 ±0.018	0.750	5/16	0.030	0.115
3	1.738 ±0.021	0.900	3/8	0.036	0.137
4	2.319 ±0.027	1.200	1/2	0.048	0.181
5	2.784 ±0.032	1.500	5/8	0.060	0.216
Formulas	T=0.93W −0.006 Tolerances = ±(0.01W +0.002)	0.3P	P/8	0.012P	0.07W +0.006

All dimensions in inches.

By thus setting the five principal dimensions of the chain for each of the thirteen pitches in each of the three series, the Committee has done all that is necessary to insure the interchangeability of spare links between chains of various makes and also the interchangeability between chains and sprockets.

Tolerance for Chain Length. New chains under standard measuring load may be one sixty-fourth inch per foot over length, but must not be under length.

Roller Transmission Chain Sprockets

Table 2 and its accompanying figure give in convenient form the standard dimensions of chain sprockets as far as width, clearance and transverse sections are concerned.

Roller Transmission Chain Sprocket-Tooth Form and Sprocket-Tooth Cutters

Historical Note. The first tooth forms for roller-chain sprockets were designed upon the theory that the tooth action was similar to that of gear teeth, the chain being regarded as analogous to a rack. It was, however, soon found that when chains had been in use a short time the wear at the joints caused an elongation of the pitch of the chain, thus destroying perfect registration with the sprocket teeth which resulted in rough action and rapid wear. The sprocket teeth were then redesigned to provide for the chain elongation by making the tooth gap somewhat greater than the diameter of the chain roller, but with little or no modification in the contour of the tooth, which was so shaped that the chain roller bore almost squarely against the sprocket tooth, throwing practically the whole load on a single tooth.

Meanwhile, the use of roller chains became more extensive and the demands made on them more exacting. This condition naturally led, both in this country and abroad, to a more careful study of the action between chains and sprocket teeth than had heretofore been given to the subject, and it soon became apparent that by giving some obliquity to the face of the sprocket tooth, quite different and decidedly better results could be obtained. The action of the forces called into play can be readily analyzed by the graphic method of laying out a parallelogram of forces which will show in true proportion the initial tension on the chain, the resultant thrust on the sprocket tooth (determined by the degree of obliquity selected) and a balancing force passed on to the ensuing links of the chain where this action is repeated in a lessening amount.

By this method the load on a chain may be distributed over several teeth of the sprocket and at the same time, by extending the oblique portion of the sprocket tooth a suitable distance, make it possible for a chain of elongated pitch to slide outward on this oblique face until it finds a pitch circle on the sprocket coinciding with the lengthened pitch of the chain. These general findings were freely exchanged among the chain manufacturers and one of the English companies published a brochure on the subject. During the war more pressing matters prevented an interchange of opinion on this subject, but never the less most of the sprocket manufacturers evolved tooth forms along these lines.

It is now proposed to effect an agreement upon one standard form that shall supersede the various individual designs, and the formula now presented by the Joint Committee for adoption is a composite of the best features of the various tooth shapes that have been tried out and pronounced satisfactory.

Sprocket Tooth Form (See Fig. 1)

P = pitch of chain
D = nominal roller diameter
N = number of teeth in sprocket
D' = diameter of seating curve = $1.005\ D + 0.003$ in.

$$A = 31^\circ + \frac{90^\circ}{N}$$

$$ws = 0.8\ D$$

$$B = 13^\circ - \frac{18^\circ}{N}$$

xz = a circular arc whose center is at w
zy = a straight line perpendicular to wz

$$xy = 1.3\ D \times \sin\left(25^\circ - \frac{90^\circ}{N}\right)$$

ek = a line perpendicular to st

H = height of tooth crest above the chord st = $0.35\,P$

qy = a line parallel to wz with q so located that the circular arc through y will pass through k, thus forming a pointed tooth.

Outside Diameter of Sprocket = Pitch Diameter +

$$P\left(0.7 - \tan\frac{90^\circ}{N}\right) = \text{(approx.) } P.\,D. + P\left(0.7 - \frac{1.592}{N}\right)$$

$$E = O.\,D. \times \sin\frac{180^\circ}{N}$$

SPROCKET-TOOTH CUTTERS (SEE FIG. 2)

Cutters shall be designed for 6, 7-8, 9-11, 12-17, 18-34, 35 teeth and over.

The number of teeth on which each cutter shall be based is, $M = \frac{2\,N\,n}{N+n}$, where N and n are the maximum and minimum number of teeth to be cut by any given cutter. A sprocket having N teeth will thus have a pressure angle which departs the same amount from the desired pressure angle as one having n teeth.

The values of M for the various cutters are respectively, 6, 7.47, 9.90, 14.07, 23.54 and 65.42 teeth.

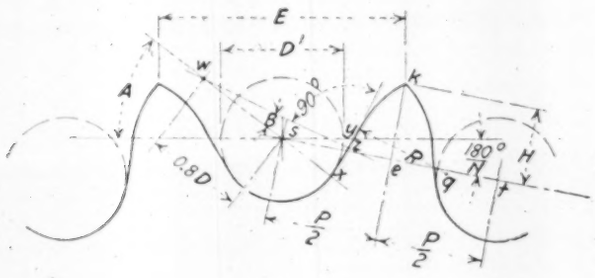


FIG. 1

Cutter numbers shall be respectively, 6, 7½, 10, 14, 24 and 65.

$D' = 1.005\,D + 0.003$ in.

$A = 31^\circ + \frac{90^\circ}{M}$

$ws = 0.8\,D$

$B = 13^\circ - \frac{18^\circ}{M}$

xz = a circular arc with w as the center

zy = a straight line perpendicular to wz

$xy = 1.3\,D \sin\left(25^\circ - \frac{90^\circ}{N}\right)$

$sc = \frac{1}{2}\,P$

$ck = H = 0.35\,P$

qq = a line parallel to wz

q = a point so located that the arc yk, struck from q as a center, will pass through k

The radius R may be determined graphically.

Where the same roller diameter is used on chains of two different pitches (as ⅝-in. roller, 1-in. pitch; and ⅝-in. roller, 1¼-in. pitch), cutters Nos. 6 and 7½ shall be designed for the longer pitch, and may be used for cutting sprockets of the shorter pitch. Cutters Nos. 10, 14, 24 and 65 shall be designed for the shorter pitch and may be used to cut sprockets of the longer pitch.

W = width of cutter = $1.02 \times O.\,D. \times \sin\frac{180^\circ}{n}$, to the next higher 32nd inch; where $O.\,D.$ equals the outside diameter of the sprocket with the larger pitch and the lowest number of teeth to be cut with the cutter.

NOTE: The specifications to the cutter maker may be simplified if w and z are located as follows:

$$a = 0.8 \times D \times \sin\left(31^\circ + \frac{90^\circ}{M}\right)$$

$$b = 0.8 \times D \times \cos\left(31^\circ + \frac{90^\circ}{M}\right)$$

$$xz = 2.6 \times D \times \sin\left(6.5^\circ - \frac{9^\circ}{M}\right)$$

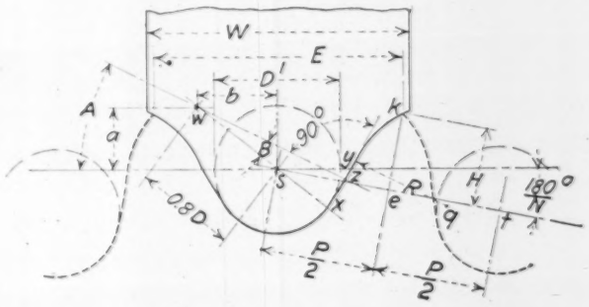


FIG. 2

This proposed standard tooth form and the cutters which produce it have slight modifications from those in general use, but the principles involved have all been thoroughly tried out and the compromises that have been made to produce a standard are in no case large enough to influence the result. Sprocket teeth cut to this form have been in very general use for a number of years.

Standard chains made to fit the old form of sprocket teeth will fit the new form as well, but they will run better on the new sprockets.

STANDARD UNIFORM SYSTEM FOR NUMBERING CHAINS

In this system of numbering, each chain number consists of three parts, the first indicated by the first one or two digits; the second by the last digit, and the third part by the letter which follows the figures. The rule for fixing the number of any standard chain is as follows:

a The left-hand figures shall denote the number of one-eighth (⅛) inches in the pitch

b The final figure shall denote the series to which the chain belongs. "0" stands for the heavy series, "1" for the medium series, and "2" for the light series

c The letters "W" and "N" following the figures shall denote whether the chain is wide or narrow.

Thus, if the pitch is ⅜ in. and the chain is a wide one of the heavy series, its number is 30W. Again, if its pitch is 1¾ in. and it is a narrow chain of the medium series, the standard number is 141N.

To provide for rollerless bushing chains the committee proposes the use of the digits 5, 6 and 7 in place of 0, 1 and 2.

LIBRARY NOTES AND BOOK REVIEWS

THE AIRCRAFT HANDBOOK. By Fred H. and Henry F. Colvin. Second edition. McGraw-Hill Book Co., Inc., New York, 1921. Cloth, 5 x 8 in., 415 pp., illus., $4.

This work was first published in 1918 under the titie, The Aircraft Mechanics' Handbook and was intended to meet the wartime need for a book for airplane mechanics. It has now been thoroughly revised, and increased in scope to meet the needs occasioned by the development of commercial aviation. The book is intended to give a good general knowledge of the principles involved in the design of airplanes and their motors, without describing details and to show how both planes and motors are assembled, cared for and repaired.

AUTOMATEN. By Ph. Kelle. Julius Springer, Berlin, 1921. Cloth, 6 x 9 in., 426 pp., illus., 144 marks.

This work treats of automatic and semi-automatic lathes, screw-machines and similar machine tools. The book first explains the various systems of automatic machinery, and follows this by a detailed discussion of such special parts as driving mechanisms, work holders, feeding devices, gearing and turret heads. Machines

and appliances for special classes of work are also described. The volume is thoroughly illustrated with drawings and photographs of modern German tools.

AUTOMOBILTECHNISCHES HANDBUCH. By Richard Bussien. Tenth edition. M. Krayn, Berlin, 1921. Cloth, 5 x 7 in., 1194 pp., illus., $2.

This pocket-book of automotive engineering is intended primarily for designers and builders, for whom it provides the formulas, technical data, standards and other information usually needed, in convenient form. The first division of the book is given over to general subjects, such as the properties of materials, engine fuels, lubricants, standards, gearing and chain drives. The second division takes up in detail the calculations of mechanical traction, the organs of power transmission, motors, speedometers, electric lighting and starting apparatus, accounting, motor boats, motor plows, fire engines, etc. This edition has been carefully revised.

THE CASE-HARDENING OF STEEL. By Harry Brearley. Second edition. Longmans, Green & Co., New York, 1921. Cloth 6 x 9 in., 207 pp., illus., $6.

This work, which first appeared in 1914, has been out of print for some years. It is intended for those actively engaged in the commercial manufacture of case-hardened objects, and for this reason is arranged to appeal to the workshop experiences and observation of craftsmen.

DIE DRAHTSEILBAHNEN. By P. Stephan. Third edition. Julius Springer, Berlin, 1921. Cloth, 6 x 9 in., 459 pp., illus., 150 marks.

This work is presented as a complete treatise on wire ropeways. The first chapter is devoted to a historical account of their development. This is followed by a description of the various details, such as cables, towers, cars and buckets, landing stations and protective devices. Chapter III gives examples of the use of ropeways for transportation in mountainous lands, for river crossings and as conveyors in various industries; while Chapter IV presents the various types. Chapter VI discusses the economic aspects of the subject and legislation. The closing chapter considers erection and operation.

THE EFFICIENCY OF PUMPS AND EJECTORS. By E. C. Bowden-Smith. D. Van Nostrand and Co., New York, 1920. Cloth, 6 x 9 in., 205 pp., plates, diagrams, $5.

This book discusses their efficiency with regard to a single problem the raising of crude sewage, the author's object being to enumerate and discuss those points which tend to economy, and to suggest methods of increasing efficiency. The problem is treated from three points of view, mechanical efficiency, commercial efficiency and sanitary efficiency.

ENGINEERING INSTRUMENTS AND METERS. By Edgar A. Griffiths. D. Van Nostrand Co., New York, 1921. Cloth, 7 x 10 in., 360 pp., illus., diagrams, $7.50.

The writer has attempted to give a brief review of the appliances which have been devised for the measurement of some of the fundamental quantities of mechanical science, such as length, screw threads, area, volume, velocity, force, mass, work and temperature. The book should enable the reader to appreciate the advantageous and drawbacks of the various types of instruments for making any particular measurement, and to choose the instrument best suited to his requirements. References to literature on the subject accompany each chapter.

ENGINEERING OF POWER PLANTS. By Robert H. Fernald and George A. Orrok. Second edition. McGraw-Hill Book Co., Inc., New York, 1921. Cloth, 6 x 9 in., 595 pp., illus., tables, $5.

This is an epitome of the subject arranged for classroom use, in which an especial effort has been made to awaken a realization of the fact that engineering, although based on exact sciences, is not itself an exact science, but requires the application of judgment, and to give the student some idea of the commercial side of engineering. The present edition includes corrections, slight modifications and reasonable additions.

THE ENGINEERS AND THE PRICE SYSTEM. By Thorstein Veblen. B. W. Huebsch, Inc., New York, 1921. Cloth, 5 x 8 in., 169 pp., $1.50.

Contents: On the Nature and Uses of Sabotage; The Industrial System and the Captains of Industry; The Captains of Finance and the Engineers; On the Danger of a Revolutionary Overturn; On the Circumstances which Make for a Change; A Memorandum on a Practical Soviet of Technicians.

This series of papers is reprinted from the *Dial*, where they appeared during 1919. They discuss certain difficulties involved in the American industrial situation, and present the author's views concerning the way in which they will be solved.

FOUNDRYWORK. By Ben Shaw and James Edgar. Sir Isaac Pitman & Sons, Ltd., London and New York, 1921. (Pitman's technical primer series.) Boards, 4 x 6 in., 115 pp., illus., $1.

This book is intended to supply engineers responsible for the designing machines that involve castings with some knowledge of the fundamental principles applied to their production in the foundry, in order that the difficulties involved in the casting of intricate forms may be understood by the designer and avoided in the design when possible.

GASOLINE AND OTHER MOTOR FUELS. By Carleton Ellis and Joseph V. Meigs. D. Van Nostrand Co., New York, 1921. Cloth 6 x 9 in., 709 pp., diagrams, $10.

The authors of this work have endeavored to prepare a substantially complete survey of the field, which would include a description of practically every process of making gasoline and of most other motor fuels of prominence or promise. The chief fuels considered are gasoline, benzene, alcohol and shale and asphalt oils. Much attention has been given to patent literature.

HANDBUCH DES WASSERBAUES. By Hubert Engels. Second edition. Wilhelm Engelmann, Leipzig, 1921. 2 vol., 7 x 11 in., diagrams.

The first edition of Engels' Handbuch des Wasserbaues, published in 1914, was intended to meet the lack of a modern work covering the entire field of hydraulic engineering in a uniform manner. The second edition has been revised and enlarged.

The work is divided into ten sections treating of the occurrence and movement of water, hydrology, river works, weirs, dams and water-power plants, protection of land, agricultural hydraulic works, navigation, ship locks, river canalization and ship canals, and harbors. Each of these is an extensive summary of modern theory and practice, accompanied by a list of "sources."

THE HIGH COST OF STRIKES. By Marshall Olds. G. P. Putnam's Sons, New York, 1921. Cloth, 6 x 8 in., 286 pp., $2.50.

In this book the author has attempted to analyze the costs to the public and to labor itself of the strike epidemic which followed the war and to show, as concretely as possible, the results, to labor and the whole country, of the theories of the professional labor leader as they become apparent in this large-scale demonstration. He endeavors to make clear the wasteful absurdity of strikes as a means of controlling the division of the proceeds of production, and suggests other measurements for adjusting labor questions.

INDUSTRIAL ORGANIZATION AND MANAGEMENT. By Hugo Diemer. La Salle Extension University, Chicago, 1921. Cloth, 6×8 in., 291 pp., illus., $3.

Contents: The Principles of Business Organization; Types of Organization; Locating an Industry; Manufacturing Plants and Equipment; Buying; Receiving, Storing, and Recording Materials; Planning; The Determination of Costs; Methods of Collecting Material and Labor Costs; The Distribution of the Expense Burden; Standardization; Scientific Management; Time and Motion Studies; Wage Systems; Welfare and Betterment Work; Employment Problems; Reports to Executives.

The contents illustrate the general purpose and scope of this book. The volume is intended for beginners and sets forth the elements of the subject clearly and concisely.

THE MANUFACTURE OF PULP AND PAPER. Volume 2. By J. J. Clark and T. L. Crossley. First edition. McGraw-Hill Book Co., Inc., New York, 1921. Cloth, 6 x 9 in., 182 pp., illus., $5.

This is the second volume of the series of textbooks prepared under the direction of the educational committees of the pulp and paper associations of the United States and Canada, as a course of study bringing together the fundamental facts of mathematics and elementary science and the principles and practice of paper and pulp making. The present book is devoted to mechanics, hydraulics, elementary electricity and chemistry. It is adapted for home study as well as for classroom instruction.

THE ENGINEERING INDEX

(Registered U. S. Patent Office.)

THE ENGINEERING INDEX presents each month, in conveniently classified form, items descriptive of the articles appearing in the current issues of the world's engineering and scientific press of particular interest to mechanical engineers. At the end of the year the monthly installments are combined along with items dealing with civil, electrical, mining and other branches of engineering, and published in book form, this annual volume having regularly appeared since 1906. In the preparation of the Index by the engineering staff of The American Society of Mechanical Engineers some 1200 technical publications received by the Engineering Societies Library (New York) are regularly reviewed, thus bringing the great resources of that library to the entire engineering profession.

Photostatic copies (white printing on a black background) of any of the articles listed in the Index may be obtained at a price of 25 cents per page, plus postage. A separate print is required for each page of the larger periodicals, but wherever possible two small or medium-sized pages will be photographed together on the same print. The bill will be mailed with the print. When ordering photostats identify the article by quoting from the Index item: (1) Title of article; (2) Name of periodical in which it appeared; (3) Volume, number, and date of publication of periodical; (4) Page numbers. Orders should be sent to the Engineering Societies Library, 29 West 39th Street, New York.

ACCIDENT PREVENTION

Building Construction. Prevention of Accidents in the Erection of Steelwork. Contract Rec., vol. 35, no. 25, June 22, 1921, pp. 605–608. Instructions issued by construction firm to its foremen engaged in placing of structural steel. Rules governing handling of erection equipment and tools.

AERODROMES

Design. The Effect of Temperature and Altitude of Aerodrome in the Taking-off of Aeroplanes. P. G. Cundry. Aeronautical Jl., vol. 25, No. 126, June 1921, pp. 290–300, 7 figs. Design of aerodromes suitable for conditions in South Africa. Paper read before South African Assn. for Advancement of Science.

AERONAUTICAL INSTRUMENTS

Steering Gages. German Gyro Gauges. Alfred Gradenwitz. Aeronautics, vol. 20, no. 401, June 23, 1921, pp. 451–452, 3 figs. Description of Drexler aircraft steering gage fitted on large fighting aeroplanes of German army.

AEROPLANE ENGINES

ABC Wasp. Standard Engine Report on ABC Wasp Radial Aeronautical Engine Rated at 170 Hp. at 1800 R.P.M. U. S. War Dept., Air Service Information Circular, vol. 2, no. 197, April 30, 1921, 23 pp., 26 figs. Results: Normal hp. full throttle, 169.5 at 1800 r.p.m.; fuel consumption at normal hp., 0.592 lb. per hp.-hr. at 1800 r.p.m.; brake m.e.p. at normal speed, 111.2 lb. per sq. in. at 1800 r.p.m.; total dry weight, 289.15 lb.; dry weight per hp., 1.705 lb.

Developments. The Requirements of Aeronautic Powerplant Development. G. J. Mead and L. E. Pierce. Jl. Soc. of Automotive Engrs., vol. 9, no. 1, July 1921, pp. 23–32, 2 figs. Review of developments of various engine types, analysis of effect of their characteristics on aeroplane performance and consideration of proper installation of powerplants in aeroplane.

French. French Aeroplane Engines in 1920 (Les moteurs d'aviation français en 1920). M. Martinot-Lagarde. Aéronautique, vol. 3, nos. 19–20, Jan. 1921, pp. 296–305, 11 figs. Panhard-Levassor, Schneider, Renault, Salmson, Bréguet, Henri-Paul and Rhône.

Fuels. The Use of Commercial Low-Test Automobile Gasoline in Aviation Engines. U. S. War Dept., Air Service Information Circular, vol. 3, no. 216, April 30, 1921, 12 pp., 6 figs. With commercial low-test automobile gasoline power developed was 7 per cent less at normal speed than that obtained with domestic aviation gasoline. With mixture of low-test automobile gasoline and 6 per cent xylidine by volume, 5-hr. run with regular operation was obtained.

Heaters. Test of Airplane Engine Heater. U. S. War Dept., Air Service Information Circular, vol. 3, no. 232, May 25, 1921, 4 pp., 2 figs. Object of test was to determine possible cause of unsatisfactory service rendered by engine heaters.

Manifold. Eliminating Crankcase Dilution by Manifold Development. G. P. Dorris. Jl. Soc. of Automotive Engrs., vol. 9, no. 1, July 1921, pp. 35–36, 4 figs. Type of manifold in which admission pipe is cast integrally over exhaust pipe. Exhaust ports form hot spot immediately above carburetor inlet.

Starting Switches. Operating Tests of Magnetically Operated Starting Switches U. S. War Dept., Air Service Information Circular, vol. 3, no. 214, April 30, 1921, 6 pp., 6 figs. Bijur switch was found unsatisfactory. Hart switch, U. S. L. switch and Diamond-H switch proved satisfactory for production.

Supercharging. An Analysis of the Effect of Supercharging. U. S. War Dept., Air Service Information Circular, vol. 2, no. 195, April 15, 1921, 11 pp., 8 figs. Analysis of typical performance of aeroplane fitted with supercharging device.

Some Experiments on Supercharging in a High Speed Engine. Harry R. Ricardo. Automobile Engr., vol. 11, no. 151, June 1921, pp. 219–224, 20 figs. Comparative graphic study of performance with supercharging device and normal.

AEROPLANE PROPELLERS

Wheel. Wheel Propeller for Aircraft. Aeronautics, vol. 20, no. 399, June 9, 1921, p. 414, 6 figs. Patented wheel propeller built in such a manner that number of wing planes placed in vicinity of periphery of wheel and parallel to wheel axis, adjust themselves during rotation of wheel and become active only during half revolution of wheel, while during other half of revolution of wheel their position will be tangential to wheel.

AEROPLANES

Aerofoils. Airfoil Data on American and British Airfoils. U. S. War Dept., Air Service Information Circular, vol. 2, no. 197, April 30, 1921, 129 pp., 63 figs. Tables of coefficients and graphs of angle of incidence for 32 American models and 32 British models.

All-Metal. The All-Metal Aeroplane in Germany (L'avion métallique en Allemagne). Roger Couturier. Aéronautique, vol. 3, no. 24, May 1921, pp. 194–200, 9 figs. Junkers types.

Corrosion of Metal Parts. Methods for Preventing the Corrosion of Metal Parts of Aeroplanes. Aerial Age, vol. 13, no. 16, June 27, 1921, pp. 369–370, 1 fig. Graph giving results of comparative experiments on lasting qualities of various protecting methods. Air Service Information Circular.

Preliminary Report on Investigation of Methods for Preventing the Corrosion of Metal Parts of Airplanes. U. S. War Dept., Air Service Information Circular, vol. 3, no. 211, April 30, 1921, 4 pp., 1 fig. Corol compound was found to be best organic corrosion preventative. Zinc plating, it was determined, offers best protection against corrosion of metallic coatings tested.

Design. Some Possible Refinements in Design. W. R. Douglas Shaw. Aeronautics, vol. 20, no. 401, June 23, 1921, pp. 453–454, 10 figs. Suggestions in regard to airscrew distribution, balanced ailerons, wing section and seating accommodation.

The Loads and Stresses in Aeroplanes. John Case. Aeronautics, vol. 20, no. 402, June 30, 1921, pp. 475–477, 6 figs. Model experiments with elevators of different sizes. (Continuation of serial.)

French Commercial Types. New French Commercial Airplanes. Aviation, vol. 11, no. 2, July 11, 1921, pp. 48. Spad-33 6-Seater and Potez-IX 5-Seater.

Performance. Airplane Performance and Design Charts. L. V. Kerber. Aviation, vol. 10, nos. 24 and 25, June 13 and 20, 1921, pp. 748–751, 2 figs., and 780–784, 15 figs., June 13: Graphical solution of empirical-theoretical method of predicting performance of aeroplane of which are known weight, area, horsepower and external characteristics; also method for determining weight and area of aeroplane of given horsepower and external characteristics which is to be designed to realize a required performance. June 20: Charts for computing rate and time of climb for aeroplanes fitted with Liberty 12, Hispano-Suiza and similar engines.

Steady Motion, Theory of. General Theory of the Steady Motion of an Airplane. George de Bothezat. Nat. Advisory Committee for Aeronautics, report no. 97, 1921, 70 pp., 27 figs. Development of chart representing aeroplane steady-motion performance.

Wings. Ground-Plane Influence on Airplane Wings. A. F. Zahm and R. M. Bear. Aviation, vol. 10, no. 26, June 27, 1921, pp. 807–808, 5 figs. Test made on single British R.A.F. 6 aerofoil at 40 m.p.h. in wind tunnel at Washington navy yard. From Jl. Franklin Inst.

The Handley Page Wing. Aeronautical Jl., vol. 25, No. 126, June 1921, pp. 263–278 and (discussion) 279–289, 31 figs. Record of experimental work carried out with a view to overcoming phenomenon of "burbling."

Stresses. The Deflection of Supporting Planes and Stress of Material (Tragflächendurchbiegung und Stoffbeanspruchung). A. Proll. Zeit. für Flugtechnik u. Motorluftschiffahrt, vol. 10, no. 11–12, June 28, 1919, pp. 121–124, 6 figs. Calculation of increase of stress due to deflection of supporting planes.

Zeppelin Passenger. The 1000-Hp. Passenger Aeroplane of the Zeppelin Works in Staaken (Das 1000 PS-Verkehrsflugzeug der Zeppelinwerke in Staaken). Ad. K. Rohrbach. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 23, June 4, 1921, pp. 591–594, 12 figs. Monoplane, designed by author and made entirely of duralumin, reached on trial flight a speed of 211 km. per hr. with engines somewhat throttled. The four 260-hp. Maybach engines are placed side by side on wing.

AIR COMPRESSORS

Hydraulic. Experiences in Construction and Operation of Hydraulic Compressors in the Harz (Germany) (Bau- und Betriebserfahrungen mit Hydrokompressoren im Harz), K. Rubach. Glückauf, vol. 57, no. 16, Apr. 16, 1921, pp. 361–367, 9 figs. Development of theory of hydraulic compressors and operating experiences, based on which suggestions are drawn for their constructional arrangement. Future possibilities of their use.

Small. A Small Compressor (Klein-Kompressor), M. Prölss. Chemiker-Zeitung, vol. 45, no. 27, Mar. 3, 1921, p. 220, 3 figs. Small air compressor exhibited at Leipzig fall exhibition, constructed in four sizes for supplying 3, 10.6, 12.7, and 29.5 cu.m. of air per hour at pressure of 6 atmos. Advantages of its use in laboratories, repair workshops, etc.

AIR LIFT

Raising Liquids. Compressed-Air Lifts for Raising Liquids. A. T. Cross. Mech. World, vol 69, No. 1798, June 17, 1921, pp. 462–463, 3 figs. Formulas and graphs for computing efficiency of installation.

AIRCRAFT CONSTRUCTION MATERIALS

Plymetl. A New Structural Material. Elec. Ry.

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NOTE.—The abbreviations used in indexing are as follows:

Academy (Acad.)
American (Am.)
Associated (Assoc.)
Association (Assn.)
Bulletin (Bul.)
Bureau (Bur.)
Canadian (Can.)
Chemical or Chemistry (Chem.)
Electrical or Electric (Elec.)
Electrician (Elecn.)
Engineer[s] (Engr.[s])
Engineering (Eng.)
Gazette (Gaz.)
General (Gen.)
Geological (Geol.)
Heating (Heat.)
Industrial (Indus.)
Institute (Inst.)
Institution (Instn.)
International (Int.)
Journal (Jl.)
London (Lond.)
Machinery (Machy.)
Machinist (Mach.)
Magazine (Mag.)
Marine (Mar.)
Materials (Matls.)
Mechanical (Mech.)
Metallurgical (Met.)
Mining (Min.)
Municipal (Mun.)
National (Nat.)
New England (N. E.)
Proceedings (Proc.)
Record (Rec.)
Refrigerating (Refrig.)
Review (Rev.)
Railway (Ry.)
Scientific or Science (Sci.)
Society (Soc.)
State names (Ill., Minn., etc.)
Supplement (Supp.)
Transactions (Trans.)
United States (U. S.)
Ventilating (Vent.)
Western (West.)

Jl., vol. 57, no. 24, June 11, 1921, pp. 1091–1092. Composite of wood and sheet steel manufactured by cementing thin sheet-metal faces to relatively thick core of light-weight material. Suggested for car roof, interior panels, bins and shelves.

Streamline Wire. The Effect of Zinc Plating on the Physical Properties of Streamline Wire. Aerial Age, vol. 13, no. 16, June 27, 1921, pp. 368–369, 1 fig. From results of bend and torsion tests it is concluded that zinc plating makes streamline wire brittle. Air Service Information Circular.

AIRSHIPS

Performance. Comparative Study of Performance of Various Dirigibles (Étude comparative du rendement des divers dirigeables), M. Champsaur. Aéronautique, vol. 3, no. 24, May 1921, pp. 189–193 7 figs. French and German types.

R38. H.M. Airship R38. Engr., vol. 131, no. 3415, June 10, 1921, pp. 610–611 and 620, 5 figs. Characteristics: Length, 695 ft.; diameter, 85 ft. 4 in.; capacity, 2,700,000 cu. ft.; total normal lift, 83 tons; disposable lift, 50 tons; endurance at full speed, 5000 mi.; estimated ceiling, 25,000 ft.

ZR.2. "ZR.2" ("R.38"). Flight, vol. 13, no. 23, June 9, 1921, pp. 287–289, 6 figs. Characteristics; Length, 695 ft.; diameter, 85 ft. 4 in.; capacity 2,700,000 cu. ft.; total lift under normal conditions, 83 tons; total horsepower, 2100.

ALCOHOL

Industrial. Industrial (Including Power)—Alcohol Charles H. Bedford. Jl. Royal Soc. of Arts, vol. 49, no. 3577, June 10, 1921, pp. 472–482 and (discussion) pp. 482–486. Possibilities of establishing within British Empire industrial alcohol industry.

Industrial Alcohol and Prohibition Enforcement Chem. & Metallurgical Eng., vol. 24, no. 25, June 22, 1921, pp. 1088–1093. Before Committee on Industrial Alcohol, Am. Chem. Soc. Administration and enforcement of existing law are denounced.

Industrial Alcohol (L'alcool industriel), Charles Blanchet. Revue de l'ingenieur et Index Technique, vol. 28, no. 5, May 1921, pp. 211–219. Economics of alcohol synthesis from acetylene. (Concluded.)

ALCOHOL ENGINES

Tests. Tests with Alcohol Engines (Undersökningar å Spritmotorer), E. Hubendick. Teknisk Tidskrift (Mekanik), vol. 51, nos. 2, 3 and 4, Feb. 9, Mar. 9, and Apr. 13, 1921, pp. 25–31, 45–52 and 69–73, 23 figs. Comparison of efficiency and weight of engines for alcohol and for gasoline with same dimensions and same power. Basic principles of design. Results of tests show degree of compression to be from 7 to 9 for alcohol alone or mixed with gasoline or benzol. In spite of high degree of compression, output remains practically unchanged. Alcohol engines with flywheel are 20 per cent heavier than gasoline engines and 15 per cent dearer. Denaturing of alcohol.

ALLOY STEELS

Tests. Comparative Tests of Steels at High Temperatures, R. S. MacPherran. Chem. & Metallurgical Eng., vol. 24, no. 26, June 29, 1921, pp. 1153–1155, 13 figs. Determination of comparative properties of various alloy steels at high temperatures with a view to obtaining information as to best material for use under operating conditions of 600 to 1000 deg. fahr. It was found that introduction of metals forming carbides tends to strengthen steels at high temperatures. Paper read before Am. Soc. for Testing Matls.

ALLOYS

Microstructure. Micrographic Study of Alloys and of the Structure of Tungsten Steels by Their Slow Cooling (L'emploi des refroidissements très lents pour l'étude micrographique des alliages et la structure des aciers au tungstène), A. Portevin. Comptes rendus des Séances de l'Académie des Sciences, vol. 172, no. 61, April 18, 1921, pp. 964–967, 2 figs. Record of experiments.

[See also BEARING METALS; COPPER ALLOYS; IRON ALLOYS; MONEL METAL; NON-FERROUS METALS.]

ALUMINUM

Casting Losses. Losses in Aluminum and Aluminum-Alloy Melting, Robert J. Anderson. Brass World, vol. 17, no. 6, June 1921, pp. 154–156. Method of estimating metal and fuel losses in melting aluminum.

ALUMINUM ALLOYS

Melting Losses. Aluminum-Alloy Melting Loss Great, Robert J. Anderson. Foundry, vol. 49, no. 13, July 1, 1921, pp. 520–522. Description and estimation given of losses sustained in melting aluminum and aluminum alloys. Oxidation and heavy fuel consumption due to inefficient furnace operation principal causes. Report prepared for United States Bureau of Mines.

Reverberatory Furnaces. Aluminium and Its Alloys in Engineering—V, John G. A. Rhodin. Engr., vol. 131, no. 3414, June 3, 1921, pp. 586–589, 4 figs. Description of aluminum reverberatory furnaces.

Uses. Aluminium and Its Alloys in Engineering, John G. A. Rhodin. Engr., vol. 131, nos. 3415 and 3416, June 10 and 17, 1921, pp. 622–623 and 635–636. June 10: Behavior of aluminum castings. June 17: Principles of designing dies for facilitating their use in the foundry.

AMMONIA

Properties. The Isometrics of the Ammonia Superheated Region and the Vapor Pressure of Liquid Ammonia, Frederick G. Keyes. A.S.R.E. Jl., vol. 7, no. 5, Mar. 1921, pp. 371–379, 1 fig. Experiments at research laboratory of Mass. Inst. of Technology.

APPRENTICES, TRAINING OF

Railways. A Railway Company's System of Engineering Apprenticeship. Eng. & Indus. Management, vol. 5, no. 24, June 16, 1921, pp. 692–694. Practice of Orleans Ry. Co. Translated from Revue générale des Chemins de Fer.

Systems. Apprenticeship System of the Southern Pacific Railway, Frank A. Stanley. Am. Mach., vol. 55, no. 1, July 7, 1921, pp. 12–15, 8 figs. Methods of instruction. Rates of pay while learning. Summary of periods of instruction.

Programs of Apprenticeship and Special Training in Representative Corporations, J. V. L. Morris. Am. Mach., vol. 54, no. 25, June 23, 1921, pp. 1081–1083, 1 fig. Plan of instruction followed in plant of Westinghouse Air Brake Co., Wilmerding, Pa.

ARTILLERY

Anti-Aircraft. The future of Anti-Aircraft Artillery, Robert V. Morse, Jl. U. S. Artillery, vol. 54, no. 6, June 1921, pp. 583–593, 3 figs. Future developments.

AUTOGENOUS WELDING

Low-Carbon Steel. The Influence of Foreign Substances in Low-Carbon Steel on Its Weldability in Melting Flame (Ueber den Einfluss der Fremdkörper im Flusseisen auf seine Schweissbarkeit in der Schmelzflamme), C. Diegel. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 24, June 11, 1921, pp. 626–629, 5 figs. Influence of C, Si, Mn, P and S in low-carbon steel on quality of seam with autogenous welding. Results so far of tests being carried out by Julius Pintsch Corp. show injurious influence of silicon.

AUTOMOBILE ENGINES

Air-Cooled. Fins for Air-Cooled Engines. Automobile Engr., vol. 11, no. 151, June 1921, p. 213, 1 fig. Formulas for determining dimensions of fins.

Gas-Producer Plant. Suction Gas-Producer Plant for Motor Vehicles. Engineering, vol. 111, no. 2894, June 17, 1921, pp. 739–741, 18 figs. Parker plant manufactured by Producer-Gas Plants, of London.

High-Compression. Developing a High-Compression Automotive Engine, Fred C. Ziesenheim. Jl. Soc. of Automotive Engrs., vol. 9, no. 1, July 1921, pp. 5–19, 16 figs. Experimental work in development of mechanical injection system conducted at Carnegie Inst. of Technology, Pittsburgh.

Manifold Design. Intake Manifold Practice in Europe, W. F. Bradley and S. Gerster. Automotive Industries, vol. 44, no. 25, June 23, 1921, pp. 1370–1375, 41 figs. Based mainly on French practice.

Pistons. A Novel Piston. Automobile Engr., vol. 11, no. 151, June 1921, pp. 212–213, 4 figs. Allen design, aiming at minimum ring friction and even pressure.

Research. A Suggested Programme for Automobile Research, Geo. W. Watson. Automobile Engr., vol. 11, no. 151, June 1921, pp. 225–230. Utilization of low-grade fuel; alcohol, ether, benzol, and mixtures thereof; and solid fuels. Study of materials for valves, and design of pistons, piston rings and cylinders; cooling systems; silencers; lubrication; shafts; bearing metals; gears; spring suspension; brakes and transmission.

Vibrating Force. Running Balance and Uniformity of Crankshaft Effort in 8-Cylinder 60 Degree Vee Engines, P. M. Heldt. Automotive Industries, vol. 44, no. 26, June 30, 1921, pp. 1427–1429, 4 figs. Analytical study of vibrating forces in 8-cylinder Vee engine. One conclusion reached is that maximum vibrating force of 60 deg. eight-cylinder engine is only 61.2 per cent of that of 90 deg. 8-cylinder Vee engine.

AUTOMOBILE FUELS

Benzol. Nearly 65 Miles on One Gallon of Benzol, W. F. Bradley. Automotive Industries, vol. 44, no. 25, June 23, 1921, pp. 1364–1365, 2 figs. New record is established in French "grand prix" fuel-consumption test by Gregoire, Citroen and other small cars, as well as by some larger cars. Nearly all makes entered in 183-cu. in. class and smaller make over 30 m.p.h.

Research. Influence of Various Fuels on Engine Performance—IV, H. R. Ricardo. Automotive Industries, vol. 45, no. 1, July 7, 1921, pp. 8–13 and 17, 6 figs. When all fuels are used with same compression ratio, power output is proportional to energy content of charge, but fuels which can be used with higher compression ratios without detonation are capable of developing higher maximum power than those which detonate at lower pressures. From Automobile Engr.

Where Are We Getting in Efforts to Solve the Fuel Problem? Herbert Chase. Automotive Industries, vol. 44, no. 24, June 16, 1921, pp. 1241–1250, 15 figs. Review of research and development work covering results of tests and improvements in design made public during past year, together with comments on future developments that appear to be promising.

[See also AEROPLANE ENGINES, Fuels; BENZOL.]

AUTOMOBILES

Body Suspension. A New Method of Automobile Body Suspension, George J. Mercer. Automotive Industries, vol. 44, no. 24, June 16, 1921, pp. 1261–1263, 4 figs. There are two supports on each side for connecting body to frame and body sills are outside frame.

Examples of European Practice in Three- and Four-Point Suspension, M. W. Bourdon. Automotive Industries, vol. 44, no. 26, June 30, 1921, pp. 1419–1420, 6 figs. Tendency is toward three-point type, though majority of cars still employ four-point arrangement. One maker employs self-aligning ball bearing as support for extended front end of crankcase.

Propulsive Suspension of Automobile Body (L'voiture a suspension propulsive), Pierre Maréchal. Nature (Paris), no. 2456, April 30, 1921, pp. 279–282, 4 figs. There are no shafts common to wheels on opposite sides, and each of rear wheels is driven by separate mechanism. Body is supported by springs engaging in rod attached to wheel pointing at small angle toward direction of motion. Obstacles force rods against springs, which transmit impact by elasticity to car in direction of motion.

Design in U. S. The Trend of Design in the United States of America. Automobile Engr., vol. 11, no. 151, June 1921, pp. 215–217, 20 figs. Notes on 1921 New York automobile show.

Four-Wheel Brakes. Engineering Analysis of European Four-Wheel Brakes, W. F. Bradley and S. Gerster. Automotive Industries, vol. 44, no. 24, June 16, 1921, pp. 1267–1273, 20 figs. Engineering features of chief types and results of tests.

Front-End Drive. Problems of the Front-End Drive in Automobiles, J. Edward Schipper. Automotive Industries, vol. 44, no. 24, June 16, 1921, pp. 1296–1301, 16 figs. Typical three-wheel Morse silent chain drive. Present and future trend in front-end drive.

Manufacture. Manufacturing Methods on a Light Car. Automobile Engr., vol. 11, no. 151, June 1921, pp. 206–211, 18 figs. Tooling equipment at works of A.B.C. Motors, Ltd., Surrey, England.

Shock Absorbers. Suspension Shock Absorber for Automobiles. Sci. Am. Monthly, vol. 4, no. 1r July 1921, pp. 69–70, 5 figs. Construction employing differential lever principle to meet variable conditions.

Starting and Lighting System. Oscillograph Measurements of Instantaneous Values of Current and Voltage in the Battery Circuit of Automobiles, George W. Vinal and C. L. Snyder. U. S. Dept. of Commerce, Technologic Papers of Bur. of Standards, no. 186, May 2, 1921, 23 pp. 28 figs. Oscillograms of instantaneous and average values of current and voltage.

Transmission Gears. A New Transmission Designed to Facilitate Gear Shifting. Automotive Industries, vol. 44, no. 25, June 23, 1921, pp. 1366–1367, 6 figs. Secondary clutch completely disconnects transmission from propeller shaft during interval of gear shafting. Shifting is accomplished by imparting rotary motion to slotted camshaft in gear box which actuates shifting yokes. Shifting lever mounted on steering column.

AVIATION

Civil, Australia. Commercial Aviation in Australia, R. A. Hendy. Aviation, vol. 11, no. 2, July 1921, pp. 49. There are nearly sixty companies or persons engaged independently in aviation.

Civil, Canada. Civil Aviation in Canada. Aviation, vol. 11, no. 2, July 11, 1921, pp. 45, 1 fig. Summary of Canadian civil aviation certificates and licenses issued during 1920 and the first five months of 1921.

Commercial. Commercial Aviation 1920 (La navigation aérienne commerciale en 1920), M. Emile Pierrot. Aéronautique, vol. 3, nos. 19–20, Jan. 1921, pp. 307–316, 8 figs. European developments.

France. French Aviation in 1921, Capt. de Lavergne Aviation, vol. 10, no. 24, June 13, 1921, pp. 745–747. Developments in military and civil aviation.

French Aerial Navigation Regulations. Organization of French Aeronautics. Aerial Age, vol. 13, no. 16, June 27, 1921, pp. 367–368 and 365. Regulations for aerial navigation in France. Establishment of Nat. Meteorological Bur. Note from Nat. Advisory Committee for Aeronautics.

International Law. Aerial Navigation and International Law (La navigation aérienne et le droit international), Henri Bouché. Aéronautique, vol. 3, no. 24, May 1921, pp. 216–220. Study of protocols before French senate. Centrifugal study.

Legislation. Air Navigation Directions—I. Aeronautics, vol. 20, no. 400, June 16, 1921, pp. 442–444. Survey of air-navigation acts enacted from 1911–1919.

London-Paris Service. London-Paris Service. Aeronautics, vol. 20, no. 400, June 16, 1921, pp. 428–431, 3 figs. Report on installation work on engines, oil, water and gasoline systems, engine design, aeroplane design, etc. (To be continued.)

Safety and Economy on the London-Paris Air Service. Flight, vol. 13, no. 24, June 16, 1921, pp. 408–409. Report of committee appointed by Royal Aeronautical Society "to discuss what is required to insure the safe and economical working of an aeroplane carrying mails and passengers between London and Paris.

Radiogoniometry. Aerial Navigation by Radiogoniometry (La navigation aérienne par la radiogoniométrie). Vie technique & industrielle, vol. 2, no. 21, June 1921, pp. 214–217, 8 figs. Operation of radiogoniometry.

Soaring Flight. Soaring and Gliding Experiments in Germany. Stanley Yale Beach. Aviation, vol. 11, no. 1, July 4, 1921, pp. 13–14, 2 figs. Records of flights made.

Technique. The Technique of Flight—II, R. M. Hill. Aeronautical Jl., vol. 25, no. 126, June 1921, pp. 301–311, 2 figs. Analysis of longitudinal balance of aeroplane.

AVIATORS

School for Flight Surgeons. Report of the Medical Research Laboratory and School for Flight Surgeons for the Calendar Year 1920. Air Service Information Circular, vol. 3, no. 231, May 20, 1921, 12 pp.

B

BALANCING

Turbines. Four Years of Balancing Practice, N. W. Akimoff. Jl. Am. Soc. of Naval Engrs., vol. 33, no. 2, May 1921, pp. 261–267, 6 figs. Summary of facts established.

BEAMS

Non-Uniform Section. Deflection of Beams of Non-uniform Section. U. S. War Dept., Air Service Information Circular, vol. 3, no. 213, April 30, 1921, 10 pp., 10 figs. Comparison of graphical and analytical methods of design.

Reinforced-Concrete. Reinforced-Concrete Beams—I, T. C. Broom. Mech. World, vol. 69, no. 1799, July 24, 1921, pp. 484–486, 1 fig. Graph for designing rectangular concrete beam with single reinforcement.

Trussed. The Calculation of Trussed Beams (Zur Berechnung von Fachwerkträgern), L. Gensen. ZentralBlatt der Bauverwaltung, vol. 41, no. 44, June 1, 1921, pp. 273–275, 11 figs. Following theorem is derived: The mobility of a biaxial symmetrical link polygon inscribed in a circle is finite.

BEARING METALS

Alloys. Bearing Metals (Ueber Lagermetalle), Bruno Simmersbach. Chemiker-Zeitung, vol. 45, no. 27, Mar. 3, 1921, pp. 216–219. Bronze, white metals and phosphor bronze are said to be best adapted for bearing metals. Review of various patented alloys which have been successfully used.

Self-Lubricating. New Self-Lubricating Bearing Material. Automotive Industries, vol. 45, no. 1, July 7, 1921, pp. 15, 3 figs. Mixture of bronze and graphite developed by General Electric Co.

White-Metal. Some Properties of White Metal Bearing Alloys at Elevated Temperatures, John R. Freeman, Jr. and R. W. Woodward. U. S. Dept. of Commerce, Bur. of Standards, Technologic Papers, no. 188, April 5, 1921, 16 pp., 7 figs. Apparatus for determining yield point and ultimate strength of white-metal bearing alloys at tempefatures up to 100 deg. cent. Record of tests.

BEARINGS

Automobile Engines. Automobile Engine Bearings, W. Betterton. Metal Industry (lond.), vol. 18, no. 24, June 17, 1921, pp. 461–464, 7 figs. Formula for computing dimensions.

BEARINGS, BALL

Types. Comparison of Various Types of Ball Bearings, H. R. Reynolds and R. W. Sellew. Am. Mach., vol. 54, no. 25, June 23, 1921, pp. 1065–1067, 7 figs. Relation between overall width tolerances and radial play mathematically demonstrated. Difference in radial play before and after mounting.

BELT DRIVE

Tension Rollers. Indirect Friction-Disk Drive by Means of Tension Rollers (Tension-Roller Belt Drive) [Indirekter Reibscheibenantrieb durch Druckrollen (Druckrollen-Riementrieb)], H. Schomburg. Der praktische Maschinen-Konstrukteur, vol. 54, no. 10, Mar. 10, 1921, pp. 45–48, 11 figs. Improved tension-roller belt drive patented by Koch & Co. Machine Works, Remscheid-Vieringhausen, Germany.

BENZOL

Specifications. British Standard Specification for Benzol for Motor Fuel. British Eng. Standards Assn., no. 135, Jan. 1921, 9 pp., 3 figs. Defined as liquid consisting essentially of mixture of benzene and not more than 30 per cent by volume of toluene and xylenes.

BLAST-FURNACE GAS

Pressure Regulation. Automatic Gas Regulation with the Aid of the Reineke Regulator (Selbsttätige Gasreglung mit Hilfe des Reglers von Reineke), R. Goetze. Glückauf, vol. 57, no. 8, Feb. 19, 1921, pp. 169–174, 9 figs.

BLAST FURNACES

Design. Designing Hot Blast Stoves, W. E. Groume-Grimailo. Iron Age, vol. 107, no. 25, June 23, 1921, pp. 1677–1680, 3 figs. Proportioning passes and brickwork of checkers for work they have to do. Combustion and heat-transfer problems.

BOILER FEEDWATER

Degassing. Degassing and Purification of Boiler Feed-Water, Paul Kestner. Proc. Instn. Mech. Engrs., no. 4, June 1921, pp. 291–330 and (discussion) pp. 330–360, 21 figs. Physical and chemical study of reactions involved. Classification and description of methods.

Purification. Boiler Feed Water Purification, S. B. Applebaum. Chem. and Met. Eng., vol. 25, no. 1, July 6, 1921, pp. 23–26. Outline of respective merits of various methods used for boiler feedwater treatment, with special reference to advantages of Zeolite water-softening process.

BOILER FIRING

Oil Fuel. Liquid Fuel for Steam-Raising, N. A. Anfilogoff. Jl. Soc. Chem. Ind., vol. 40, no. 11, June 15, 1921, pp. 205R–209R, 4 figs. Typical conversion of Babcock and Wilcox boiler to oil fuel without alteration of brickwork.

BOILER OPERATION

Draft Regulator. Wilkins Pressure Regulator. Power, vol. 53, no. 26, June 28, 1921, pp. 1041, 3 figs. Apparatus for draft and stoker control.

Factor of Evaporation. The Calculation of Boiler Performance, W. B. Campbell. Power House, vol. 14, no. 11, June 5, 1921, pp. 28–29, 1 fig. Graph for determining factor of evaporation.

Heat Balances. Calculating Boiler Heat Balances, H. D. Fisher. Combustion, vol. 5, no. 1, July 1921, pp. 18–24, 7 figs. Graphs.

Water Meters. The Use of Water Meters in Steam-Boiler Operation (Die Verwendung von Wassermessern im Dampfkesselbetriebe). Elektrotechnischer Anzeiger, vol. 38, no. 72, May 7, 1921, pp. 455–457. Details of recent types of open and closed water meters, both of which systems are said to give good results.

BOILERS

Cleaning. The Influence of Soot and Scale Removal on the Economy of Steam-Boiler Plants (Der Einfluss der Reinigung auf die Wirtschaftlichkeit der Dampfkesselanlage), M. Schimpf. Glückauf, vol. 57, no. 15, Apr. 9, 1921, pp. 345–346. Results of tests carried out on a double-flue boiler showing saving of 15 per cent of fuel through cleaning.

The Removal of Sludge from Steam Boilers (Das Abschlammen des Dampfkessels). Chemiker-Zeitung, vol. 45, no. 3, Jan. 6, 1921, p. 30, 1 fig. Discusses unobserved losses in steam operation and importance of sludge removal from boilers. Details and advantages of blow-off valve constructed by firm of Gustav F. Gerdts, Bremen, Germany.

Electrically Heated. Useful Possibilities of the Electric Boiler (Något om den elektriska ångpannans användningsmojligheter), Otto Stålhane. Teknisk Tidskrift, vol. 51, no. 4, Apr. 6, 1921, pp. 56–61, 8 figs. Describes boiler types and discusses three possibilities, namely (1) complete reconstruction of boiler through installation of resistances in the tubes and walling up of the smoke flues; (2) installation of boilers which can be electrically heated part of year and with coal when electric current is not constantly available; and (3) if current is constant, but not available at all times of the day, the use of a special electric boiler. Electric boilers offer possibility for complete utilization of water power.

Marine. See MARINE BOILERS.

Vertical. The Construction of Small Vertical Boilers (Ueber den Bau von kleinen stehenden Kesseln), E. Hohn. Zeit. des Bayerischen Revisions-Vereins, vol. 25, no. 10, May 31, 1921, pp. 84–86, 3 figs. Explosion occurring in Switzerland in 1915 was attributed to poor quality of welded seam between smoke tube and fire box end, and to use of bumped heads. To prevent recurrence of similar accidents regulations have been adopted by Swiss boiler manufacturers.

Water Concentration. Concentration of Water in Steam Boilers. Victor J. Azbe. Power, vol. 54, no. 2, July 12, 1921, pp. 46–48, 4 figs. Description of densimeter, an apparatus for determining water concentration by sodium chloride method.

BOILERS, WATER-TUBE

Vertical. The Piedboeuf Vertical Water-Tube Boilers (Der Biedboeuf-Steilrohrkessel), Paul Koch. Der praktische Maschinen-Konstrukteur, vol. 54, no. 11, Mar. 17, 1921, pp. 81–82, 2 figs. Vertical water-tube boilers with improved Garbe tube sheets pressed to provide flat surface for tube holes.

BORING MACHINES

Taper Head. A New Taper Head for Boring and Turning Mills. Machy. (Lond.), vol. 18, no. 455, June 16, 1921, pp. 332–333, 5 figs. Device patented by Geo. Richards & Co., Manchester, England.

BRAKES

Electric vs. Pneumatic. Experiences with Different Types of Brakes on the Berlin Street Railway (Erfahrungen mit verschiedenen Bremsarten bei der Berliner Strassenbahn), E. Kindler. Elektrische Kraftbetriebe u. Bahnen, vol. 19, no. 10, May 24, 1921, pp. 112–114, 1 fig. Experiences with pneumatic and electric brakes, from which it is concluded that the electric brake is best adapted for street-railway operation because of its simplicity and low cost of maintenance.

Train. Improvements in Train Braking. Sci. Am., vol. 124, no. 26, June 25, 1921, pp. 506–507, 4 figs. Combination of straight and automatic air braking designed for control of train on steep grades.

Virginian Demonstration of Double-Capacity Brake. Ry. Mech. Engr., vol. 95, no. 7, July 1921, pp. 428–432, 8 figs. Train of 16,000 tons handled down 1.5 per cent. grade.

BRASS

Lead Determination. The Determination of Small Amounts of Lead in Brass, Francis W. Glaze. Jl. Indus. & Eng. Chemistry, vol. 13, no. 6, June 1921, pp. 553–554. Electrolytic method for determination of lead as lead dioxide.

High-Resistance. High Resistance Brass, Pendleton Powell. Brass World, vol. 17, no. 6, June 1921, pp. 151–153. Manufacture of special brasses and bronzes to resist large stresses, especially bronzes for ship propellers. Translated from Bulletin Technologique des Arts et Métiers.

BUILDING CONSTRUCTION

Cost Accounting. Construction Accounting under Uniform System. Elec. Rev. (Chicago), vol. 79, no. 1, July 2, 1921, pp. 6–9. Each item of expenditure classified and recorded in form to segregate costs on various plants and lines and on various specific parts of such plants and lines. Examples of accounts.

Construction Costs. W. N. Connor. Jl. Boston Soc. Civil Engr., vol 8, no. 5, May 1921, pp. 157–197, 12 figs. Suggested forms for keeping records of costs in building construction.

Steel-Frame. Reducing the Cost of Steel-Frame Building, R. Fleming. Jl. Western Soc. of Engrs., vol. 26, no. 6, June 1921, pp. 220–229. Method of reducing cost of construction.

C

CABLEWAYS

Aerial. Aerial Cableways (Les transporteurs aériens a cables), F. Cretin. Génie Civil, vol. 78, no. 19, May 7, 1921, pp. 385–390, 4 figs. Study of stresses in cable and resistance of carriage to travel. Notes on design.

CAR DUMPERS

German. Devices for the Unloading of Railway Cars (Vorrichtungen zur Entleerung von Eisenbahnwagen), G. W. Kochler. Fördertechnik u. Frachtverkehr, vol. 14, nos. 10 and 11, May 13 and 27, 1921, pp. 110–112 and 124–126, 15 figs. Describes several types.

CARS

Armored Ends. Great Central Railway Vehicles with Armoured Ends, Collision Buffers and Interlocking Fenders. Ry. Gaz., vol. 34, no. 23, June 10, 1921, p. 883, 1 fig. Object of construction is to provide buffing and interlocking arrangement whereby underframes of carriages are prevented from getting out of alignment and any tendency to mounting or over-riding is prevented.

Buffer Plates. Avoiding Rupture of Buffer Plates by Proper Heating Treatment (Studio sulla fragilita e sulla rigenerazione per ricottura dei respingent ferroviari), P. Forcella. Rivista tecnica delle Ferrovie Italiane, vol. 19, no. 5, May 15, 1921, pp. 130–134, 16 figs. on 3 supp. plates. Based on photomicrographic examinations of broken surfaces.

Couplings. Impact and Its Relation to Damage Claims, J. A. Pilcher. Ry. Age, vol. 71, no. 2, July 9, 1921, pp. 77–79, 1 fig. Graph showing relation between speed at which cars are coupled and force of impact. Evils are avoided when speed does not exceed 2 miles an hour.

Dump. Large Dump Cars for Use in the Absolute-Removal System of Stripping Overburden from Coal. Coal Age, vol. 19, no. 25, June 23, 1921, pp. 1117–1118, 3 figs. Car will carry rocks up to 18 tons weight, gives 5-ft. clearance for dumping and will hold 43 cu. ft. of material and discharge running or standing and right or left.

Heavy Types. Heavy Locomotives for the Southern Pacific. Ry. Age, vol. 71, no. 1, July 2, 1921, pp. 15–17, 4 figs. Pacific and Santa Fe types. Characteristics: Pacific, tractive effort, 43,660 lb.; cylinders, 25 in. by 30 in.; weight, total engine, 297,800 lb.; wheelbase, driving, 13 ft.; Santa Fe, tractive effort, 75,150 lb.; cylinders, 29½ in. by 32 in.; weight, total engine, 385,900 lb.; wheelbase, driving, 22 ft. 10 in.

Insulation. Insulation of Freight and Passenger Cars, Wm. N. Allman. Ry. Mech. Engr., vol. 95, no. 7, July 1921, pp. 444–449, 3 figs. Theoretical and practical considerations; values of various materials; calculating heat transmission.

CARS, FREIGHT

All-Steel. New All-Steel Wagon Stock for India. Ry. Gaz., vol. 34, no. 24, June 17, 1921, pp. 930–931, 4 figs. High-capacity hopper and rail wagons constructed by Midland Ry. Carriage & Wagon Co., Birmingham, for Bengal-Nagpur Ry. Dimensions: Extreme length over buffers, 44 ft. 11 in.; length of body, 35 ft.; width over underframe solebars and inside body, 9 ft.; tare weight, 21 tons 17 cwt.

Draft-Gear Tests. Draft Gear Tests of the Railroad Administration. Ry. Mech. Engr., vol. 95, no. 7, July 1921, pp. 435–441, 6 figs. Car-impact tests at T. H. Symington Co. testing plant at Rochester, N. Y. Methods of combining and interpreting records.

Reinforced-Concrete. Reinforced-Concrete Railway Cars (Eisenbahnwagen aus Eisenbeton), A. Kleinlogel. Verkehrstechnik, vol. 38, no. 4, Feb. 5, 1921, pp. 45–48, 3 figs. Economical advantages, construction and useful scop of reinforced-concrete cars.

CARS, MAIL

Unit-Container. Epoch-Making Experiments with Unit-Container Mail Cars. Transportation World, vol. 3, no. 4, June 1921, pp. 11–12, 2 figs. Removable container cars operated by New York Central.

CARS, PASSENGER

Disinfection. The Disinfection Plant of the Vienna Municipal Street Railway (Entkeimungsanlage der Wiener städtischen Strassenbahnen im Bahnhof Simmering). Zeit. des Oesterr. Ingenieur- u. Architekten-Vereines, vol. 73, no. 20–21, May 28, 1921, p. 141. Cleaning of railway cars, etc., is effected by means of formalin vapors with vacuum in boiler, with which a thorough and rapid disinfection is insured without damage to cars.

Heating. Two-Part Coupling for Car Steam Hose ("Unikum," Kuppelung für zweiteilige Dampfheizschläuche), L. Peuser. Organ für die Fortschritte des Eisenbahnwesens, vol. 58, no. 8, Apr. 15, 1921, pp. 78–79, 4 figs. Couplings adopted by Czecho-Slovakian State Railway for cars of the Kaschau-Oderberg railway.

CARS, REFRIGERATOR

Inspection. Transportation Economics of the Refrigerator Car, H. R. Newlean. A.S.R.E. Jl., vol. 7, no. 5, Mar. 1921, pp. 383–389. Inspection practice of Fruit Dispatch Co., vendors for United Fruit Co.

CARBURETORS

Tests. Trials of German Carburetors for Using Non

Volatile Fuels, Benno R. Dierfeld. Automotive Industries, vol. 45, no. 1, July 7, 1921, pp. 4–5, 2 figs. Winning instruments in competitive tests made partly on road and partly on laboratory testing stand.

CAST IRON

Research. British Iron Research Association Meets, Joseph Horton. Foundry, vol. 49, no. 13, July 1, 1921, pp. 531–532. Progress made in development of British Cast Iron Research Association.

CEMENTS

Acid-Proof. Acid-Proof Cements (Säurefeste Kitte). H. Kleinlogel. Chemiker-Zeitung, vol. 45, no. 54, May 5, 1921, pp. 432–433. Satisfactory results obtained from tests with cements from firm of Rössler, Bensheim, Germany, to be used for lining reinforced-concrete containers for different kinds of acids.

CENTRAL STATIONS

Operation. Organization and Operation of Interconnected Electric Plants (L'esprit des groupements de centrales, leur organisation—Leur exploitation), Fernand Courtoy. Association des Ingénieurs électriciens sortis de l' Institut Electro-technique Montefiore, vol. 3, no. 5, 1921, pp. 99–146, 15 figs. Regulations for establishment of corporations to engage in exploitation of centralized electrical systems. Technical and financial study.

Southern U. S. The Industrial Load in the Southern States. Elec. World, vol. 77, no. 26, June 25, 1921, pp. 1473–1477, 2 figs. Industrial plants of this section of nation have adopted electric service to marked extent during past decade. Seventy-five per cent of electrical energy consumed is purchased from central-station systems.

CENTRIFUGALS

Water-Driven. Some Recent Developments in Water-Driven Centrifugals, F. J. Broadbent. Engineering, vol. 111, no. 2894, June 17, 1921, pp. 744–745, 6 figs. Pelton-wheel-driven machines with cage of 72 in. diameter.

CHEMICAL INDUSTRIES

Prohibition and. Alcohol and the Chemical Industries, J. M. Doran. Jl. Indus. & Eng. Chemistry, vol. 13, no. 6, June 1921, pp. 564–565. Plea for regulation of prohibition in such a manner as not to interfere with chemical industries.

CLUTCHES

Design. American and British Practice in Clutch Design, Herbert Chase. Automotive Industries, vol. 44, no. 24, June 16, 1921, pp. 1302–1313, 28 figs. Advantages and disadvantages of various types of clutches are discussed and merits and demerits of many design features pointed out. Notes on theory of design and tabulation of dimensions, pressures, capacity, etc. of many makes.

Practice and Theory in Clutch Design, Herbert Chase. Jl. Soc. of Automotive Engrs., vol. 9, no. 1, July 1921, pp. 39–52, 28 figs. Comparative study of American and British practices in clutch design.

Hydraulic. High-powered Hydraulic-Clutch for Diesel-Driven Tankers. Motorship, vol. 6, no. 7, July 1921, pp. 579, 1 fig. Tests by British Admiralty of Hele-Shaw device for motorships.

COAL

Boghead. Boghead Coals (Die Bogheadkohle). H. Winter. Glückauf, vol. 57, nos. 12 and 13, Mar. 19 and 26, 1921, pp. 257–261 and 285–288. Results of investigation show that the boghead mineral is a coal similar to cannel coal, but with considerably higher content of available hydrogen.

COAL BREAKERS

Hard, Low-Volatile Coal. Sizing and Preparing a Hard Low-Volatile Coal in the Broad Top Region to Compete with Anthracite, Donald J. Baker. Coal Age, vol. 19, no. 26, June 30, 1921, pp. 1151–1154, 8 figs. Breaker built to prepare five different sizes.

COAL DUST

Sampling. Coal-Dust Sampling and Methods Adopted in Practice, R. C. Smart. Iron & Coal Trades Rev., vol. 101, no. 2779, June 3, 1921, pp. 753–754, 3 figs. Regulations of British Navy. Paper read before South Wales Inst. Engrs.

COAL HANDLING

China. Coal-Handling Plant for the Han-Yeh-Ping Iron and Coal Company, China. Iron & Coal Trades Rev., vol. 102, no. 2780, June 10, 1921, pp. 779–780, 6 figs. Electrically operated plant.

German Plant. Mechanical Coal-Handling Installation for a Steam-Boiler Plant Mechanische Kohlenbeschickeinrichtung für eine Dampfkesselanlage, gebaut von W. Fredenhagen in Offenbach (Main), Ernst Blau. Fördertechnik u. Frachtverkehr, vol. 14, no. 10, May 13, 1921, pp. 108–110, 5 figs. Automatic installation constructed by W. Fredenhagen, Offenbach, Germany, consisting of an inclined elevator and two scraper conveyors.

Piers. Mechanical Trimmers Facilitate Coal Loading, P. G. Lang, Jr. Ry. Age., vol. 70, no. 25, June 24, 1921, pp. 1433–1436, 5 figs. Baltimore & Ohio installation at Curtis Bay piers, Md.

COAL POCKETS

Concrete. A Concrete Coal Bin of Unusual Design and Construction. Am. Architect, vol. 119, no. 2369, June 8, 1921, pp. 621–627, 13 figs. Coal bin of 1900-ton capacity designed for storage of pulverized coal.

COAL STORAGE

Fire Fighting. Extinguishing Fires in Coal Stores (Die Bekämpfung von Kohlenlagerbränden), H. Immerschitt. Feuerungstechnik, vol. 9, no. 16, May 15, 1921, pp. 145–149. Discusses effectiveness of the three different methods of combating fires, namely, through water, through smothering, and through cooling with salt solutions.

COAL TAR

By-Products. Tetralin and Dekalin. Sci. Am. Monthly, vol. 4, no. 1, July 1921, pp. 65–66, 2 figs. Illuminant and lubricant obtained from coal tar.

COAL TIPPLES

Construction. Among Other Preparation Devices at Diamond Mines Is One for Picking Each Separately, Donald J. Baker. Coal Age, vol. 19, no. 25, June 23, 1921, pp. 1111–1116, 8 figs. Cars brought to feeder by rope are fed to dump which revolves completely over, cars being held by wheel clamps. Reciprocating screens hang from rods and do not rest on rollers.

COBALT STEEL

Analysis. The Determination of Cobalt and Nickel in Cobalt Steels, G. E. F. Lundell and J. I. Hoffman. Jl. Indus. & Eng. Chemistry, vol. 13, no. 6, June 1921, pp. 540–543. Method based on electrodeposition of cobalt and nickel in solution freed from iron, chromium, tungsten, molybdenum, vanadium and copper.

COKE

Breeze. Boiler Fuel Mixture Tests, John Blizard and James Neil. Gas Rec., vol. 19, no. 12, June 22, 1921, pp. 25–27 and 34, 3 figs. Experiments conducted at Bur. of Mines to determine steaming value of coke breeze when mixed with Pittsburgh coal and fired by hand.

Metallurgical. Notes on the Value of Metallurgical Coke, G. Deladriere. Colliery Guardian, vol. 121, no. 3154, June 10, 1921, pp. 1668–1669, 4 figs. Graphs comparing relative values of different grades of coal. Translated from Revue universelle des mines.

COKE-OVEN GAS

Benzol Content. Determination of Benzol Content in Coke-Oven Gas (Die Benzolbestimmung im Koksofengas), A. Thau. Glückauf, vol. 57, nos. 22, 23 and 24, May 28, June 4 and 11, 1921, pp. 505–511, 529–536 and 550–562, 19 figs. Discussion and comparison of various domestic and foreign processes. Account of tests for determination by physical means, and description of an indicating or recording device for photometric determination of benzol in gas.

COKE OVENS

By-Product. Adaptability in Coke Oven Practice, C. R. Meissner. Gas Age, vol. 47, no. 12, June 25, 1921, pp. 503–506, 5 figs. Among features of Hazelwood plant are concrete casings for exhausters and boosters and flushing of collecting mains with condensate.

Plants. New Coke Ovens at St. Louis, Hector Prud'homme. Gas Rec., vol. 19, no. 12, June 22, 1921, pp. 19–23, 5 figs. Eight Piette type of ovens installed at plant of Laclede Gas Light Co. for test purposes. Thirty-day test run shows splendid results.

COLD SAWS

Use in Steel Works. The Use of High-Speed Cold Saws with Toothless Blade in Steel Works and Foundries (Verwendung schnellaufender Kaltsägen mit zahnolsem Sägeblatt in Hüttenwerken und Stahlgiessereien), A. Lobeck. Werstattstechnik, vol. 15, no. 12, June 15, 1921, pp. 351–353, 12 figs. Describes new cutting method for use with steel castings of a given shape and hardness.

COMBUSTION

Air Regulation. Industrial Comburimetry (La comburimétrielle industrielle), M. André Grebel. Chateur et Industrie, vol. 2, no. 13, May 1921, pp. 272–276, 3 figs. Apparatus for regulating amount of air necessary for combustion. (Concluded.)

Flue-Gas Analysis. Determination of Excess Air from Flue-Gas Analysis, R. Brown. Combustion, vol. 4, no. 6, June 1921, pp. 24–25, 1 fig. Construction of excess air chart.

Surface. Introduction of Surface Combustion in the German Industry (Zur Einführung der "flammenlosen Oberflächenverbrennung" in die deutsche Industrie), Rudolf Schnabel. Chemiker-Zeitung, vol. 45, no. 57, May 12, 1921, p. 457. Refers to organization of German Society for Surface Combustion possessing the rights of American, English and German patents.

COMPRESSED AIR

Waste. Saving Fuel by Decreasing Air Waste, N. A. Craigue. Indus. Management, vol. 61, no. 11, June 1, 1921, pp. 418–421, 3 figs. Methods of reducing waste and diminishing leaks in compressed air systems.

CONCRETE

Alkali Action. Progress in Investigation of Alkali Action on Concrete, E. C. Bebb. Concrete Products, vol. 20, no. 6, June 1921, pp. 27–29. Investigations conducted by Bur. of Standards, Reclamation Service, Drainage Investigations Office of Dept. of Agriculture and Portland Cement Assn.

Oven Drying. Effects on Concrete of Immersion in Boiling Water and Oven Drying, W. J. Schlick. Iowa State College of Agriculture & Mechanic Arts Official Publication, vol. 19, no. 44, Mar. 30, 1921, 24 pp., 13 figs. Experiments. Boiling without previous drying caused reduction in weight, while boiling following oven drying caused increase in weight, there having been marked loss in strength in each case.

Tests. Formula for Determining the Strength of Cement Concrete (Om en Fremgangsmaade til Bedömmelse af Mörtelmaterialers Egenskaber). Ingeniören, vol. 30, no. 18, Mar. 2, 1921, p. 133. Method used by Peter Lind & Co., Westminster, to test probable strength of concrete used for concrete ships during war.

Waterproofing. Some Methods of Securing Impermeability in Concrete, Ewart S. Andrews. Concrete & Constructional Eng., vol. 16, no. 6, June 1921, pp. 369–374. Classification of methods for securing impermeability. Paper read before Concrete Inst.

Waterproofing Concrete—I, J. H. Burgess. Commonwealth Engr., vol. 8, no. 8, Mar. 1, 1921, pp. 248–251. Permeability tests.

CONCRETE CONSTRUCTION

Gravity Plants. Graphic Wattmeter Checks Gravity Plant Operation. Eng. News-Rec., vol. 86, no. 25, June 23, 1921, pp. 1067–1068, 3 figs. Details of distant operations indicated on chart at construction engineers' desk.

CONCRETE CONSTRUCTION, REINFORCED

Developments. Modern Reinforced Concrete Industrial Structures (Moderne strutture industriali in cemento armato), Luigi Santarella. Industria, vol. 35, no. 8, April 30, 1921, pp. 175–179 and 180–181, 16 figs. Typical factory constructions.

CONDENSERS, STEAM

Cleaning. Removing Scale from Surface Condenser Tubes with Hydrochloric Acid, Norman G. Hardy. Power, vol. 54, no. 1, July 5, 1921, pp. 22–24, 1 fig. Apparatus and process described.

Acid Cleaning of Condensers, Norman G. Hardy. Elec. World, vol. 78, no. 2, July 9, 1921, pp. 64, 1 fig.

Developments. Recent Improvements in the Design of Condensers for Steam Engines (Recents perfectionnements des appareils de condensation des machines à vapeur d'eau), L. Jauch. Chaleur et Industrie, vol. 2, no. 13, May 1921, pp. 239–246, 3 figs. Technical study and historical survey. (To be continued.)

Water Screens. Largest Traveling Screens Installed at Cincinnati. Power, vol. 54, no. 2, July 12, 1921, pp. 62–64, 3 figs. Screening capacity is 200,000 gal. per min.

CONNECTING RODS

Machining Methods. Another Method of Machining Connecting Rods, Fred H. Colvin. Am. Mach., vol. 54, no. 25, June 23, 1921, pp. 1068–1069, 5 figs. Methods and fixtures. Facing both ends of boss at once. Drilling machine with special attachment. Boring two rods in one operation.

Machining Connecting Rods. Eng. Production, vol. 2, no. 38, June 23, 1921, pp. 744–746, 11 figs. Methods employed at leading automobile factories.

CONVEYORS

Workshop. Mechanical Conveyors for Workshops, Hubert Hermanns. Forging & Heat Treating, vol. 7, no. 6, June 1921, pp. 316–319, 10 figs. Types used in German workshops.

COPPER

Gases, Action on. The Action of Reducing Gases on Heated Copper, H. Moore and S. Beckinsale. Engineering, vol. 111, no. 2893, June 10, 1921, pp. 729–732, 8 figs. Results obtained in experiments showed that injurious effect of reducing gases on heated copper is result of their interaction with cuprous oxide always present in commercial copper. Markedly injurious effect is produced even when oxygen content of copper does not exceed 0.026 per cent. Paper read before Inst. of Metals.

COPPER ALLOYS

Copper-Tin. The Constitution of the Alloys of Copper with Tin—III and IV, John L. Haughton. Engineering, vol. 111, no. 2895, June 24, 1921, pp. 789–793, 23 figs. Transformations occurring below eutectic temperature. Photomicrographs.

Cupro-Vanadium. Non-Ferrous Applications of Vanadium, Kirby Thomas. Raw Material, vol. 4, no. 5, May 1921, pp. 167–168. Cupro-vanadium being used in brasses and bronzes.

CORROSION

Concrete Reinforcement. Reinforcing Steel in Cements Containing Blast-Furnace Slag (Eiseneinlagen in hochofenschlackenhaltigen Zementen), Richard Grün. Stahl u. Eisen, vol. 41, no. 17, Apr. 28, 1921, pp. 577–579. Laboratory tests show that an injurious rusting of iron in alkaline cement masses is impossible providing construction is sufficiently airtight. Practical experience shows that in properly prepared reinforced concrete of blast-furnace cement or of portland cement, the core iron remains permanently unchanged.

Protective Treatments. Notes on Oxydizing Cementation, Galvanization, Sherardizing and Metalizing Spraying (La cémentation oxydante. La galvanisation. La shérardisation. La métallisation par pulvérisation), J. Arnoul de Grey. Chaleur et Industrie, vol. 2, no. 13, May 1921, pp. 255–262. Exposition and comparative study of methods of protecting metallic objects against corrosion. (To be continued.)

Steam Pipes. A Case of Rust Formation (Ein Fall von Rostbildung), E. Sauer. Chemiker-Zeitung vol. 45, no. 53, May 3, 1921, p. 421. Describes case of corrosion of a steam pipe caused by carbonic-acid content of the steam, demonstrating importance of removal of gases, especially of carbon dioxide from feedwater.

COST ACCOUNTING

Overhead Costs. Budgeting Factory Overhead,

E. E. Carlson. Factory, vol. 27, no. 1, July 1, 1921, pp. 31–34, 4 figs. Experience in operation of budget plans of Fairbanks, Morse & Co. and of A. O. Smith Corp.

Uniform System. Advises Use of Uniform Cost System, Robert E. Belt. Foundry, vol. 49, no. 13, July 1, 1921, pp. 524–526. Economical advantages of introducing uniform cost system in manufacturing plants. Paper read before National Industrial Cost Conference.

COUPLINGS

Whitney Free Floating. Whitney Free Floating Coupling. Power, vol. 54, no. 1, July 5, 1921, pp. 24, 2 figs. Designed to allow for misalignments, either parallel or angular. Coupling consists of two hubs and special design of driving link.

CRANES

Tower. Tower Crane for Handling Timber. Engr., vol. 131, no. 3415, June 10, 1921, pp. 624–625, 1 fig. Designed to deal with loads of 5 tons at radius of 50 ft. and of 3 tons at radius of 100 ft.; with clear height of lift of 52 ft.

CRANKCASES

Machining Operations. Details of Crankcase Work. Am. Mach., vol. 54, no. 25, June 23, 1921, pp. 1088–1090, 9 figs. Different types of reaming fixtures. "Hand" reaming by pneumatic motor. Running in crankshaft bearings by power. Roller conveyors as labor savers.

CUPOLAS

Clays for Daubing. Cupola Daubing Clay Affects Iron, Carl Buberl. Foundry, vol. 49, no. 13, July 1, 1921, pp. 533–534. Poor and good clays for daubing cupola are defined and results of tests showing detrimental effects of poor grade of refractory given. Aluminum additions improve quality.

Oil Firing. Oil Lowers Cost of Fuel in Cupola, Karl K. Berthold. Foundry, vol. 49, no. 13, July 1, 1921, pp. 530–531. Experience at Austrian Foundry. Oil was introduced as adjunct to coke in cupola and cost of fuel was decreased in consequence as well as metal with lower sulphur content was obtained. Translated from Stahl u. Eisen.

Operation. Fitting the Cupola to Its Work, V. A. Dyer. Iron Age, vol. 107, no. 25, June 23, 1921, pp. 1675 and 1727–1729. Cupola operation. Physical and chemical factors as related to efficiency. Position of fusion zone.

CUTTING TOOLS

Design. Metal Cutting Tools—XII, A. L. DeLeeuw. Am. Mach., vol. 55, no. 1, July 7, 1921, pp. 4–9, 13 figs. Form tools; plate tools, bar tools and circular form tools. Advantages and disadvantages of each. Shaving tools and their action.

D

DIE CASTING

Developments. Latest Developments in the Die-Casting Industry. Raw Material, vol. 4, no. 5, May 1921, pp. 156–163, 13 figs.

DIESEL ENGINES

North British. The North British Diesel-Engine, Motorship, vol. 6, no. 7, July 1921, pp. 568–569, 4 figs. Four-cycle, single-acting, crosshead type developing 2300 hp.

Solid-Injection. Injection and Combustion of Fuel-Oil—IV, C. J. Hawkes. Motorship, vol. 6, no. 7, July 1921, pp. 573–574, 1 fig. Experiments with solid injection and air blast in marine Diesel-engines. (Continuation of serial.)

Standardized. Standardized Diesel Engines—V, H. R. Setz. Mar. Eng., vol. 26, no. 7, July 1921, pp. 548–552, 7 figs. Discussion of double-acting two-cycle engine and its possibilities.

DRAWINGS

Filing. Systems for Indexing and Filing Drawings. Eng. & Contracting, vol. 55, no. 25, June 22, 1921, pp. 609–611, 4 figs. Systems used by five prominent engineering and manufacturing enterprises. Paper read before Cleveland Eng. Soc.

DRILLING MACHINES

High-Power. High-Power Drilling Machines with Central Drive (Hochleistungs-Bohrmaschine mit Zentralantrieb), P. Castenholz. Der praktische Maschinen-Konstrukteur, vol. 54, no. 12, Mar. 24, 1921, pp. 49–51, 5 figs. Machine constructed by Gebhard Bischof Machine Works, Reutlingen, Germany, for single-pulley drive through vertical shaft in column.

Manufacture. Building Drilling Machines. Eng. Production, vol. 2, no. 36, June 9, 1921, pp. 694–703, 24 figs. Methods at works of Associated British Machine Tool Makers, Halifax.

Multiple-Spindle. Drilling Two Different Parts on One Machine, J. H. Moore. Can. Machy., vol. 25, no. 25, June 23, 1921, pp. 25–27, 9 figs. Uses and advantages of multiple-spindle drilling machines. Typical examples of work.

Heavy Multiple-Head Drilling Machines. Engineering, vol. 111, no. 2893, June 10, 1921, pp. 714 and 716, 2 figs. Designed by Beyer, Peacock & Co., Manchester, England, to meet requirements of locomotive and marine engine shops.

DROP FORGING

Ingots for. Billets for the Drop Forger, Harry Brearley. Forging & Heat Treating, vol. 7, no. 6, June 1921, pp. 307–313, 13 figs. Cracks, blowholes, pipe and segregates in ingots, and laps, roaks, burning clinks, flash and remnant defects in forgings are discussed.

Plants. Drop-Forge Plant Lay-Out and Equipment. Machy. (N. Y.), vol. 27, no. 11, July 1921, pp. 1039–1044, 9 figs. Drop-forging plant arranged for handling large quantities of work.

DUST

Measurement of Dustiness. The Shinizu-Wilson Cloud-Condensation Apparatus. Electn., vol. 86, no. 2247, June 10, 1921, pp. 720, 2 figs. Apparatus for measuring dustiness of atmosphere. Modifications of Wilson cloud-condensation apparatus.

E

EDUCATION, ENGINEERING

Problem of. How Should the Engineer Be Educated? F. L. Bishop, Knox Taylor, Comfort A. Adams, W. C. Spruance, Moorhead C. Kennedy, R. E. Anderson and Donald A. Hampson. Am. Mach., vol. 54, no. 26, June 30, 1921, pp. 1105–1109. Résumé of remarks expressed at joint meeting of Am. Soc. of Mech. Engrs. and Am. Inst. of Elec. Engrs.

United States. Engineering College Registration Shows 4-Per cent Gain. Eng. News-Rec., vol. 86, no. 26, June 30, 1921, pp. 1104–1106, 3 figs. Census by Eng. News-Rec. covered 48,312 students in 81 institutions located in 36 states. Mechanical engineering was most popular course.

ELASTICITY

Moduli. Elasticity. Engineering, vol. 111, no. 2893, June 10, 1921, pp. 701–702, 13 figs. Derivation of formula expressing relation between moduli of elasticity.

ELECTRIC DRIVE

Cement Industry. Electrified Cement Industry Aids Western Construction, Lloyd W. Chapman. Jl. Electricity & Western Industry, vol. 47, no. 1, July 1, 1921, pp. 7–10, 5 figs. Methods of manufacturing portland cement at Santa Cruz Portland Cement Co.

Logging Industry. Electric Applications in the Logging Industry of the Northwest, E. P. Whitney. Gen. Elec. Rev., vol. 24, no. 7, July 1921, pp. 631–638, 8 figs.

Pumps. Electric-Motor Drives for Pumps, Gordon Fox. Power, vol. 54, no. 1, July 5, 1921, pp. 2–5, 5 figs. Advantages of reciprocating and centrifugal pumps. How to figure capacities and power required. Operating characteristics. Types of motor to use for different kinds of service.

Textile Industry. Selection of Polyphase Motors, Benjamin F. Bailey. Elec. World, vol. 78, no. 1, July 2, 1921, pp. 16–19, 7 figs. Electric drive in textile industry. Comparison of electrical and physical characteristics that affect service requirements. Choice of speed, frequency weight and rating are considered. Squirrel-cage compared with wound-rotor motor.

ELECTRIC FURNACES

Arc. A New Indirect Arc Furnace. Metal Industry (Lond.), vol. 18, no. 23, June 10, 1921, pp. 442–443, 2 figs. Three-phase gyrating furnace manufactured by Volta Mfg. Co., Welland, Ont.

Inductive. Recent Progress in High-Frequency Inductive Heating, E. F. Northrup. Chem. & Metallurgical Eng., vol. 24, no. 25, June 22, 1921, pp. 1097–1100, 5 figs. Notes on design, operation, melting rate and power input of electric furnaces using high-frequency inductive heating. Electric furnaces are being used for melting precious metals at U. S. Mint and by leading silver broker. Paper read before Am. Electrochemical Soc.

Laboratory. Electric Muffle Furnaces for Laboratory Use, H. C. Kremers. Jl. Indus. & Eng. Chemistry, vol. 13, no. 6, June 1921, pp. 561; 2 figs. Muffle made up of nickel-chromium alloy wire wound around glass cylinder covered with asbestos.

Tagliaferri. Tagliaferri Electric Furnace (Le four electrique "Tagliaferri"), Mario-Marantonio. Journal du Four Electrique, vol. 30, no. 7, May 1 & 15, 1921, pp. 53–58, 9 figs. Operation and heat distribution are regulated by auxiliary electrodes. Patented by Société anonyme de Fours électriques.

ELECTRIC PLANTS

Interconnection. Power Administration Effects Economy, Fred B. Lewis. Elec. World, vol. 78, no. 2, July 9, 1921, pp. 57–58, 4 figs. Methods which have been adopted in California to operate steam and hydroelectric plants for maximum efficiency and economy of resources.

ELECTRIC WELDING, ARC

Castings. Application of Arc Welding in Machinery Construction, A. M. Candy. Elec. Rev. (Chicago), vol. 79, no. 1, July 2, 1921, pp. 1–5, 7 figs. Heavy castings damaged in shop or in operation repaired with speed by welding process. Forging weld increased its strength and quality. Paper before Soc. of Refrigerating Engrs.

Railway Shops. Electric Arc Welding in Railroad Shops, A. M. Candy. Ry. Mech. Engr., vol. 95, no. 7, July 1921, pp. 456–458, 7 figs. Explanation of the characteristics of arc-deposited metal and some samples of welding.

ELECTRICAL INDUSTRY

Developments. Personal Observations in the Industry, Arthur W. Berresford. Jl. Am. Inst. Elec. Engrs., vol. 40, no. 7, July 1921, pp. 555–560. Suggestions in regard to furthering industrial progress.

ELECTRICITY, APPLICATIONS OF

Industrial. The Use of Electricity in Special Industries in the West. Jl. Electricity & Western Industry, vol. 46, no. 12, June 15, 1921, pp. 612–624, 34 figs. Eighty-six per cent of energy sold by western power companies goes to industrial consumers. Survey of conditions.

ELEVATORS

Freight, Safeguarding. Freight Elevators. Power Plant Eng., vol. 25, no. 13, July 1, 1921, pp. 667–669, 3 figs. Safeguarding shaftways, cables, counterweights and operation. Prepared by eng. staff of Nat. Safety Council.

Governors. Electric Elevator Machinery, Overspeed Governors, M. A. Myers. Power, vol. 54, no. 2, July 12, 1921, pp. 50–51, 13 figs. Types of safety governors.

EMPLOYMENT MANAGEMENT

Testing Employees. Industrial Psychotechnology (Industrielle Pyschotechnik), A. Wallichs. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 25, June 18, 1921, pp. 648–651. Development of adaptability tests; related methods and their utilization. Discussion of results already obtained and prospects of future development.

ENAMELING

Steel. The Vitreous Enamelling of Steel and Iron, Charles M. Bowes. Metal Industry (Lond.), vol. 18, no. 23, June 10, 1921, pp. 441–442. Outline of processes.

ENGINEERS

Licensing. Ethical and Practical Considerations Regarding the Engineering Corporation. Eng. News-Rec., vol. 86, no. 26, June 30, 1921, pp. 1109–1111. Holds that ethical questions are not essentially different from those confronting individual consultants.

EXHAUST STEAM

Utilization. Generating Power with Exhaust from Mill Engines. Power Plant Eng., vol. 25, no. 13, July 1, 1921, pp. 641–646, 10 figs. Mixed-pressure turbines and regenerators installed at plant of National Enameling & Stamping Co.

EXPLOSIVES

Liquid Oxygen. The Potentialities of Liquid Oxygen Explosives, Robert G. Skerrett. Compressed Air Mag., vol. 26, no. 6, June 1921, pp. 10103–10107, 7 figs. Use of liquid oxygen in German mines.

F

FACTORIES

Reinforced Concrete. A Modern Multi-Storied Shop for Building Machine Tools, Fred H. Colvin. Am. Mach., vol. 54, no. 26, June 30, 1921, pp. 1114–1118, 11 figs. Five-story building of reinforced concrete. Notes on lighting, heating and ventilating systems, also on method of handling chips.

FACTORY MANAGEMENT

See INDUSTRIAL MANAGEMENT.

FIRE PREVENTION

Exposed Woodwork. Ignitions of Combustible Materials, Especially Exposed Woodwork, by Heat-Producing Apparatus, C. E. Worthington. Safety Eng., vol. 41, no. 6, June 1921, pp. 256–263, 2 figs. Protecting devices, notably for metal smokestacks and insulation for smoke pipe.

FIRECLAYS

Thermal Expansion. The Reversible Thermal Expansion of Fireclay and Other Refractory Materials, H. S. Houldsworth and John W. Cobb. Jl. Soc. Glass Technology, vol. 5, no. 17, May 1921, pp. 16–38 and (discussion) pp. 38–44, 12 figs. Reversible thermal expansion up to 100 deg. cent. were determined for fireclay, fireclay mixtures, ganister, alumina magnesia and carborundum.

FLUE-GAS ANALYSIS

Determination of Sulphur Dioxide and Tricxide. The Determination of Sulphur Dioxide and Sulphur Trioxide in Flue Gas and Fuming Sulphuric Acid (Ueber die Bestimmung von Schwefeldioxyd neben Schwefeltroxyd in Röstgasen und Oleum), A. Sander. Chemiker-Zeitung, vol. 45, no. 33, Mar 17, 1921, pp. 261–263, 1 fig. Method developed by author for determination of sulphur dioxide alongside of sulphur trioxide with use of only one apparatus and a single titration liquid, based on influence of mercuric chloride on sodium bisulphide.

FOREMEN

Training. Practical Methods of Training Foremen, S. Gordon Taylor. Indus. Management, vol. 62, no. 1, July 1, 1921, pp. 23–26. Experience in organization of welfare work in shipyard.

FORGING PLANTS

Layout. Building a Forge Shop for Custom Work, E. L. Shaner. Iron Trade Rev., vol. 68, no. 26, June 30, 1921, pp. 1786–1790, 7 figs. Layout of forge plant producing miscellaneous steel drop forges and forges for railroad car equipment, oil-and-gas well supply manufacturers, etc.

FORGINGS

Metal Involved. Chart for Determining Metal Involved in Forgings, H. Kilborn. Forging & Heat Treating, vol. 7, no. 6, June 1921, pp. 314–315, 1 fig.

FRAMES

Reinforced-Concrete. Axial versus Center Moment in the Calculation of Reinforced-Concrete

Frames (Ein Beitrag zur der Frage: Achsen-oder Mittelmoment bei der Berechnung von Eisenbetonrahmen), Horst Wolf. Bauingenieur, vol. 2, no. 11, June 15, 1921, pp. 304–306, 2 figs. Points out that in calculation of a frame the most accurate results can in all cases be obtained when center line is assumed to be axis of frame.

FREIGHT HANDLING

German vs. American Practice. Railway Freight Traffic (Leistungen im Eisenbahn-Güterverkehr), H. Wernekke. Fördertechnik u. Frachtverkehr, vol. 14, no. 10, May 13, 1921, pp. 107–108. Figures showing efficiency of German and American railways in freight-train traffic, from which it is concluded that while American railways show heavier traffic, German railways show a much more thorough and efficient utilization of rolling stock.

FUELS

Heat Value. Calculation of Heat Value from the Constitution of Compound (Studien über die Berechnung des Heizwertes aus der Konstitution der Verbindung), F. Otto H. Binder. Chemiker-Zeitung, vol. 45, no. 18, Feb. 10, 1921, p. 141. Discussion based on the Dulong formula for calculation of theoretical heat value of a fuel from its elementary composition.

[See also OIL FUEL; PULVERIZED COAL.]

FURNACES

Recuperator. An Automatic Recuperator Furnace. Machy. (Lond.), vol. 18, no. 454, June 9, 1921, pp. 303, 2 figs. Gas furnace designed for utilizing waste flue gases as aid to combustion.

FURNACES, ANNEALING

Oil-Fuel-Burning. Anneals Malleable with Fuel Oil, William F. Hoernke. Iron Trade Rev., vol. 68, no. 25, June 23, 1921, pp. 1728–1730, 4 figs. Conversion of coal burning annealing ovens into oil burning ovens. Operation shows that although oil is more expensive fuel, it requires less labor in handling and firing.

FURNACES, BOILER

Insulation. Boiler Furnace Insulation, Frank W. Sterling. Jl. Am. Soc. of Naval Engrs., vol. 33, no. 2, May 1921, pp. 268–284, 10 figs. Methods of testing furnace insulation.

Lignite-Burning. New Lignite Furnaces (Neue Feuerungen fur Rohbraunkohle). Der prakitsche Maschinen-Konstrukteur, vol. 54, no. 12, Mar. 24, 1921, pp. 89–90. Adjustable semi-producer-type step grate constructed by Jacques Piedboeuf, Ltd., Düsseldorf, which is said to insure proper distribution and regulation of air required for combustion and for obtaining maximum gas temperatures in furnaces, easy manipulation and cleaning facilities, especially with regard to removal of ashes and slag.

The Adaptation of Furnace Installations to Use of Lignite (Wie stelle ich am besten neine Feuerungsanlage auf Rohbraunkohlen um?), O. Binder and R. Scharf. Chemiker-Zeitung, vol. 45, no. 30, Mar. 10, 1921, pp. 237–239. Recommends installation of economically operated stepped-grate furnace.

Turbine. Cochran Boiler Fitted with the Turbine Furnace. Iron & Coal Trades Rev., vol. 103, no. 2780, June 10, 1921, p. 788, 2 figs. Tests on turbine patented furnace built by Turbine Furnace Co., London.

FURNACES, HEATING

Automatic Firing. Air Furnace Is Fired Automatically. Foundry, vol. 49, no. 13, July 1, 1921, pp. 515–517, 4 figs. Coal dumped into hopper which feeds specially designed grate as coal burns. Only manual labor necessary is that required for pulling ashes.

Continuous. Heating Furnaces and Annealing Furnaces, W. Trinks. Forging & Heat Treating, vol. 7, no. 6, June 1921, pp. 320–324, 6 figs. Comparison of different types of continuous furnaces. Test results.

FURNACES, HEAT-TREATING

Gas. The Value of Gas for Heat Treating, F. F. Cauley. Forging & Heat Treating, vol. 7, no. 6, June 1921, pp. 328–331, 8 figs. Typical modern installations.

FURNACES, HOT-AIR

Research. Investigation of Warm-Air Furnaces and Heating Systems, A. C. Willard, A. P. Kratz, and V. S. Day. University of Ill. Bul., vol. 18, no. 29, Mar. 21, 1921, 145 pp., 49 figs. Determination of efficiency and capacity of commercial warm-air furnaces under conditions similar to those existing in actual installations with leaders, stacks, and registers, to form complete system; study rating furnaces and investigations of value of insulating materials as affecting economy of furnace.

G

GAGES

Industrial. Study of Industrial Gages at International Bureau of Waste and Measures (L'étude des calibres industriels au bureau international des poids et mesures), Albert Pérard. Genie Civil, vol. 78, no. 23, June 4, 1921, pp. 477–480, 11 figs. Types of gages employed. (To be continued.)

Inspection. The Delco Inspection System, Erik Oberg. Machy. (N. Y.), vol. 27, no. 11, July 1921, pp. 1032–1034 8 figs. Description of methods used in tool and gage designing dept. of Dayton Eng. Laboratories Co., and standards of gaging adopted.

Lever. The Accuracy of Multiple Lever Gages (Die Genauigkeit mehrfacher Fühlhebel), G. Berndt. Werkstatttstechnik, vol. 15, no. 12, June 15, 1921, pp. 347–350, 2 figs. Comparison of accuracy of single and multiple levers. States that, when possible, instead of using several levers with smaller gear ratios, it is better to use a double or single lever with gear ten times as great.

GAS MANUFACTURE

Producer Process, Loss in. Thermal Losses in the Gas Producer Process, N. E. Rambush. Jl. Soc. Chem. Industry, vol. 40, no. 12, June 30, 1921, pp. 129T–137T, 5 figs. Principles by means of which it is possible to determine thermal efficiency of gasification of a given fuel without large-scale tests.

GAS MASKS

Charcoal. The Occlusion of Water by Gas-Mask Charcoal, Ben E. Brown. Physical Rev., vol. 17, no. 6, June 1921, pp. 700–706, 2 figs. Variation of amount of water with temperature was determined between 102 and 140 deg. cent. at pressure of 74 cm. of mercury. About 1/8 of water came off between 112 and 114 deg. cent.

GAS TURBINES

Combustion Chambers. Gas-Turbine Combustion Chambers, Glenn B. Warren. Power, vol. 53, no. 26, June 28, 1921, pp. 1059–1060, 2 figs. Experiments at University of Wisconsin on four types of combustion chambers.

GEAR CUTTING

Bevel-Gear Planer. Gleason 37-In. Two-Tool Bevel-Gear Planer. Am. Mach., vol 54, no. 26, June 30, 1921, pp. 1123–1125, 5 figs. Automatic machines intended for general work. Tools cut on opposite sides of tooth.

Continuous Machines. Generating Gear Teeth for Industrial Uses, J. H. Moore. Can. Machy., vol. 25, no. 23, June 9, 1921, pp. 25–27, 8 figs. Continuous type of gear-cutting machines.

Helical Gears. Cutting Large Double Helical Gears, C. S. Pettit. Machy. (Lond.), vol. 18, no. 454, June 9, 1921, pp. 308–309, 4 figs. Machines developing continuous teeth by means of rack cutter using reciprocating motion.

GEARS

Bevel. The Spiral Bevel Gear. Machy. (Lond.), vol. 18, no. 456, June 23, 1921, pp. 352–354, 3 figs. Matterson type of spiral bevel gear. Criticism of article in Machy. (Lond.), May 12, p. 174.

Design. Calculation of Special Gears, Speeds of Which Are in Geometrical Progression (Berechnung besonderer Getriebe, deren Umläufe nach einer geometrischen Reihe abjestuft sind), H. Vorwerck. Der praktische Maschinen-Konstrukteur, vol. 54, no. 10, Mar. 10, 1921, pp. 42–44, 5 figs. Method of calculation.

Frictional. Frictional Gearing (Friktionsvorgelege). Der praktische Maschinen-Konstrukteur, vol. 54, no. 22, June 2, 1921, pp. 95–96, 6 figs. Variable-speed gear constructed by Ferdinand Wiss, Valendar, Germany, for transmission of small amounts of power.

Inspection. A New System of Gear Grinding and Gear Inspection, P. M. Heldt. Automotive Industries, vol. 44, no. 26, June 30, 1921, pp. 1430–1431, 4 figs. Great accuracy of tooth and more rolling with less sliding action are claimed. Grinding machine works on generating principle and means for compensating for wear of grinding wheel are provided.

Involute. The Evolution of the Involute Gear Tooth—VI, A. Fisher. Machy. (Lond.), vol. 18, no. 456, June 23, 1921, pp. 363–366, 7 figs. Influence of pressure angle on strength of teeth.

Maag. The Maag Gears and Their Use in Street-Railway Operation (Maagzahnräder und ihre Verwendung in Strassenbahnbetriebe), Rudolf Wahn. Elektrotechnik u. Maschinenbau, vol. 39, no. 22, May 29, 1921, pp. 267–269, 6 figs. Describes Maag method of making gears and advantages of this type which is now in use on 65 street-railway lines in Switzerland. Paper read before Int. Street and Narrow-Gage Ry. Congress, Vienna.

Non-Metallic. Design and Manufacture of Non-Metallic Gears, Fred R. Daniels. Machy. (N. Y.), vol. 27, no. 11, July 1921, pp. 1005–1011. Characteristics of gears made from rawhide and fabric-base materials. Methods employed by Van Dorn & Dutton Co., Cleveland, O., in manufacture of non-metallic gears.

Skew. Skew Gear Design, F. E. Lindsay. Engineer, vol. 131, no. 3416, June 17, 1921, pp. 652, 5 figs. Graphical method.

Spur. Spur Gear Erosion, F. W. Lanchester, Engineering, vol. 111, no. 2894, June 17, 1921, pp. 733–734, 7 figs. Limitations to conditions under which it is desirable to use rolling rather than sliding contact. Difficulties which are liable to be associated with rolling conditions.

Testing Teeth. The Odontometer for Testing Gear Teeth, Earle Buckingham. Machy. (N. Y.), vol. 27, no. 11, July 1921, pp. 1029–1031, 6 figs. Apparatus consists of section of straight-sided rack with two parallel effective faces, one being fixed and other movable. Third face, set at angle to two working faces, is used to hold fixed working face in contact with flank of gear tooth.

GRINDING MACHINES

Continuous. The Churchill Continuous Rod Grinding Machine. Machy. (Lond.), vol. 18, no. 455, June 16, 1921, pp. 335–336, 3 figs. Machine manufacture by Churchill Machine Tool Co., Manchester, England.

H

HANDLING MATERIALS

Liquids. Handling and Measurement of Liquids in Factories (Bewegung und Messung von Flussigkeiten innerhalb der Fabrik), H. Rabe. Chemiker-Zeitung, vol. 45, nos. 21 and 24, Feb. 17 and 24, 1921, pp. 165–169 and 191–193, 16 figs. Devices for handling, that is, conduction and measurement of liquids, such as acids, alkalies, salt solutions, hydrocarbons, and a large number of organic and inorganic liquids, such as chlorine and other liquefied gases, alcohol and ether.

Small Plants. Purchasing and Handling Material in the Small Plant—II and III, Guy V. Sweet. Indus. Management, vol. 61, no. 11, and vol. 62, no. 1, June 1 and July 1, 1921, pp. 399–402, 6 figs., and 18–21, 7 figs. June 1: Forms for keeping records and making requisitions. July 1, Forms of material record cards.

HEAT TRANSMISSION

Building Walls. The Calculation of Heat Transmission Coefficients (Ueber die Berechnung von Wärmedurchgangszahlen), Réti Mór. Gesundheits-Ingenieur, vol. 44, no. 22, May 28, 1921, pp. 262–263, 2 figs. Points to difficulties and lack of satisfactory calculating method. In supplementary article by Karl Hencky (pp. 263–264, 1 fig.) writer explains system of coefficients developed by him.

HEATING

Industrial, Local. Industrial Applications of Local Heating with the Pyrotip, E. A. Wagner. Gen. Elec. Rev., vol. 24, no. 7, July 1921, pp. 628–631, 10 figs. Heat is generated at tip of carbon rod and is transmitted by conduction to material; it is produced by resistance of carbon tip to passage of electric current.

HEATING AND VENTILATION

Humidifying Apparatus. Humidifying Apparatus for Textile Factories. Engineer, vol. 131, no. 3416, June 17, 1921, pp. 648, 3 figs. Cleworth-Wheal air-humidifying apparatus.

HEATING, ELECTRIC

Ovens and Hot Plates. Some Thermal Characteristics of Electric Ovens and Hot-Plates, Ezer Griffiths and F. H. Schofield. Jl. Instn. Elec. Engrs., vol. 59, no. 300, April 1921, pp. 361–372, 14 figs. Specifications for conducting tests on cooking ovens.

HELICOPTERS

Design. Helicopters and Aeroplane-Helicopters (Helicoptères et avionshelicoptères), M. Lamé. Aeronautique, vol. 3, nos. 19–20, Jan. 1921, pp. 277–281, 5 figs. Aerodynamic study of helicopter, especially of support without speed, stability and propulsion.

Oemichen. The Oemichen Helicopter (L'helicoptère Oemichen). Aeronautique, vol. 3, no. 24, May 1921, pp. 213–214, 2 figs. Ascensional force is derived from small balloon and two horizontal propellers rotating in opposite directions.

HOISTS

Electric. Susquehanna Installs Electric Slope Hoist and at a Shaft Replaces Steam by Electric Drive, Lewis W. LeGrand. Coal Age, vol. 19, no. 21, May 26, 1921, pp. 941–944, 6 figs. To serve two radically different degrees of slope a "two-speed" hoist was installed. At shaft steam hoist was altered to electric drive by adding motor, gears and coupling.

HOUSES, CONCRETE

Construction Methods. New and Successful Method of Constructing Concrete Houses, D. V. Weed, Jr. Concrete Products, vol. 20, no. 6, June 1921, pp. 13–15, 4 figs. Lamouldette system employing interchangeable light steel forms or units, specially rolled and shaped for maximum strength which may be set up to either vertical or horizontal position and quickly clipped together by ingenious device to form rigid mold into which concrete is poured and structure cast as monolith.

Design. A Concrete House Scheme. Concrete & Constructional Eng., vol. 16, no. 6, June 1921, pp. 353–359, 7 figs. Typical English design.

HOUSING

Industrial. The Calder Report on the Building Situation. U. S. Dept. of Labor, Monthly Labor Rev., vol. 12, no. 6, June 1921, pp. 96–100. Report to U. S. Senate of Select Committee on Reconstruction and Production. Among recommendations is creation of "a bill to establish in Dept. of Commerce a division for the gathering and dissemination of information as to the best construction practices and methods, technical and cost data, and matters relating to city planning, etc., in order to encourage standardization and improved building practices throughout the country."

HYDRAULIC MACHINERY

Manufacture. Building Hydraulic Machinery. Eng. Production, vol. 2, no. 38, June 23, 1921, pp. 749–754, 15 figs. Procedure at representative works.

HYDRAULIC TURBINES

Francis Type. Kern River Three Development has Highest Head Francis Turbines Installed. Power, vol. 53, no. 25, June 21, 1921, pp. 996–999, 5 figs. Two vertical-shaft 22,500-hp. Francis-type turbines operating under effective head of 800 ft. Two runners are provided for each unit, one for 50-cycle and one for 60-cycle operation. Water is carried through series of tunnels aggregating 60,000 ft. in length, longest single bore being 7,132 ft.

HYDROELECTRIC PLANTS

France. Hydroelectric Installation on the Arly

River (Installation hydro-électrique de l'Arly). Francis Babey. Électricien, vol. 37, no. 1274, April 15, 1921, pp. 169–174, 8 figs. Development of 800 hp. for metallurgical works.

New England. Rebuilding an Old New England Water-Power Plant. E. H. Swett. Eng. News-Rec., vol. 86, no. 25, June 23, 1921, pp. 1062–1066, 6 figs. Special construction problems in new hydroelectric station for Jackson mills long supplied with power from individual wheels taking water from Nashua River.

Niagara Falls. Hydroelectric Development at Niagara Falls, John L. Harper and J. A. Johnson Jl. Am. Inst. Elec. Engrs., vol. 40, no. 7, July 1921, pp. 561–576, 33 figs. Also abstracts in Power, vol. 54, no. 1, July 5, 1921, pp. 26–28, 6 figs. Historical survey. Possibility of more efficient utilization of water power available for development according to international treaty, which permits utilization of 20,000 cu. ft. per sec. on American side and 36,000 cu. ft. per sec. on Canadian side.

Northwestern U. S. Electrical Construction Work in Northwestern States, W. A. Scott. Elec. Rev., (Chicago), vol. 79, no. 1, July 2, 1921, pp. 11–12. Expansion and reconstruction of hydroelectric plants.

I

ICE PLANTS

Brine Tanks. Concrete Brine Tanks, H. C. Boyden. A.S.R.E. Jl., vol. 7, no. 5, Mar. 1921, pp. 390–400. Advantages of concrete brine tanks. Principles that should be observed in their design.

South Chicago. Consumers New Ice Plant at South Chicago, Gilbert Sellers. Power, vol. 53, no. 26, June 28, 1921, pp. 1038–1040, 3 figs. Synchronous-motor-driven ammonia compressors require 25.8 kw-hr. per ton of ice.

INDICATORS

Internal-Combustion Engines. A Pressure Indicator for Internal Combustion Engines, J. Okill. Power, vol. 54, no. 1, July 5, 1921, pp. 10–11, 2 figs. Modified form of steam-engine indicator.

INDUSTRIAL MANAGEMENT

Germany. The Taylor System and Scientific Management in Germany (Das Taylor-System und die deutsche Betriebswissenschaft), G. Schlesinger. Werkstattstechnik, vol. 15, no. 11, June 1, 1921, pp. 313–317. Discusses form in which Taylor system and the Gilbreth motion studies can best be adapted to German conditions.

Graphic Methods. The Ratio Chart and Its Applications—I, Percy A. Bivins. Indus. Management, vol. 62, no. 1, July 1, 1921, pp. 10–14, 11 figs. Exposition of construction and uses of ratio charts.

Personnel. Personnel Management of the Metropolitan Life Insurance Co., Lawrence Washington. Indus. Management, vol. 62, no. 1, July 1, 1921, pp. 27–32, 8 figs.

Production Systems. Analyzing Tool Production Problems, Albert A. Dowd and Frank W. Curtis. Iron Age, vol. 107, no. 25, June 23, 1921, pp. 1671–1673, 9 figs. Method of analysis. Results of alternative methods of machining and set-up.

Budgeting Business, Park Mathewson. Indus. Management, vol. 61, no. 11, June 1, 1921, pp. 404–407, 3 figs. Planning production quotas by means of budget system.

Graphic Production Control for the Small Shop, K. J. Rahn. Indus. Management, vol. 61, no. 11, June 1, 1921, pp. 432–436, 3 figs. Control sheet.

How and Why Production Methods Increase Shop Production, E. T. Spidy. Jl. Eng. Inst. of Canada, vol. 4, no. 7, July 1921, pp. 404–408, 5 figs. General outline of modern production methods, with particular emphasis on importance of shop schedule.

The Economy of Standard Quantities. Paul E. Holden. Indus. Management, vol. 62, no. 1, July 1, 1921, pp. 34–36, 2 figs. Avoiding too frequent machine set-ups and unbalanced stocks.

Rate Setting. Serial Rate-Setting, H. P. Losely. Indus. Management, vol. 61, no. 11, June 1, 1921, pp. 409–415, 10 figs. Determining time rates on varying sizes of similar parts.

Stores Organization. Stores Organisation. Eng. Production, vol. 2, no. 38, June 23, 1921, pp. 739–742, 9 figs. Forms for keeping records.

[See also TIME STUDY.]

INDUSTRY

Selection of Industrial Sites. Choosing the New Plant Location, H. H. McCanna. Indus. Management, vol. 61, no. 11, June 1, 1921, pp. 396–398, 2 figs. Factors affecting selection of industrial sites.

INSPECTION

Managing Department. Managing an Inspection Department, George S. Radford. Indus. Management, vol. 61, no. 11, June 1, 1921, pp. 422–426, 1 fig. How to handle personnel and routine.

Methods. The Delco Inspection System, Louis Ruthenburg. Machy. (Lond.), vol. 18, no. 454, June 9, 1921, pp. 289–293, 4 figs. Methods used by Dayton Engineering Laboratories Co. for inspection of raw meterials, purchased parts, tools, equipment and gages, and manufactured product.

INTERNAL-COMBUSTION ENGINES

Temperature Measurement. Measuring Temperatures in Internal-Combustion Engines (La tecnica delle misure di temperatura nei motori a combustione interna), P. Ferretti. Rivista Marittima, vol. 54, no. 1, Jan. 1921, pp. 41–102, 37 figs. Describes hydrogen gas thermometer, resistance thermometer and Callendar, Burstall, Peterson and Wolff instruments and various results obtained by these experimenters. Deals in detail with thermo-electric thermometer and experience of Bams, Stronhal and others with this apparatus. Bibliography.

[See also ALCOHOL ENGINES; AEROPLANE ENGINES; AUTOMOBILE ENGINES; DIESEL ENGINES; INDICATORS, Internal-Combustion Engines; MARINE ENGINES, Oil; REFRIGERATING PLANTS.]

IRON

Bars, Fractures in. Unusual Fractures in Iron Bars (Merkwürdige Brucherscheinungen bei Eisenstäben), J. Grimme. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 23, June 4, 1921, pp. 603–604, 12 figs. Results of tests with iron bars which were stressed during several hundred hours. Cause for the regularly occurring fracture without defects in material has not yet been found.

Magnetic Properties. Magnetic Properties of Compressed Powdered Iron, Buckner Speed and G. W. Elmen. Jl. Am. Inst. Elec. Engrs., vol. 40, no. 7, July 1921, pp. 596–609, 22 figs. Magnetic material specially suited to construction of cores in small inductance coils and transformers such as used in telephone plants. Material is formed by grains of powdered iron, insulated and compressed. Tables and curves are given showing magnetic, electrical and mechanical properties of material.

IRON ALLOYS

Magnetic Properties. On the Influence of Low Temperatures on the Magnetic Properties of Alloys of Iron with Nickel and Manganese, Kamerlingh Onnes, Robert A. Hadfield and H. R. Woltjer. Proc. Royal Soc., vol. 99, no. A698, June 1, 1921, pp. 174–196, 11 figs. Experiments showed that iron-manganese alloys, containing higher percentages of manganese, cannot be made magnetic at atmospheric temperature by cooling to boiling point of liquid hydrogen or liquid helium.

IRON CASTINGS

Cleaning. Cleaning and Dressing Castings, F. W. Wilson. Engineering, vol. 111, no. 2893, June 10, 1921, pp. 725–727. 13 figs. Procedure and equipment. Paper read before Manchester Assn. Engrs.

IRON INDUSTRY

Germany. German Iron and Steel in Reconstruction, H. Cole Estep. Iron Trade Rev., vol. 69, no. 1, July 7, 1921, pp. 25–30, 3 figs. Pig-iron production in first 5 months of 1921 was 6,000,000 metric tons; steel ingot production, 6,400,000 metric tons. Corresponding figures for 1913 were 19,300,000 and 18,940,000 metric tons.

J

JIGS

Design. Tool Engineering, Albert A. Dowd and Frank W. Curtis. Am. Mach., vol. 54, nos. 25 and 26, June 23 and 30, 1921, pp. 1078–1080, 5 figs., and 1119–1122, 7 figs. June 23: Closed jigs for annular and straight holes. Locating and assembling jigs. June 30: Design of drill jigs, indexing and trimming jigs; drilling and reaming indexing fixtures and four-sided jigs for accurate work.

Tool Engineering, Albert A. Dowd and Frank W. Curtis. Am. Mach., vol. 55, no. 1, July 7, 1921, pp. 18–22, 11 figs. Design of drill jigs. Principles and methods of indexing. Index plungers and latches. Combined index and latch. Specific examples of indexing jigs.

L

LABOR

Italy. Labor Unrest in Italy, Alfred Maylander. U. S. Dept. of Labor, Monthly Labor Rev., vol. 12, no. 6, June 1921, pp. 137–259. Rôle played by labor organization and political bodies in present unrest among industrial and agricultural labor. Extent to which economic causes have operated to bring about labor unrest, and measures that have been taken to abate it. Developments in syndicalist control of industries.

LABORATORIES

Research. The Rudge-Whitworth Research Laboratory. Machy. (Lond.), vol. 18, no. 454, June 9 1921, pp. 301–303, 5 figs. Measuring instruments developed at research laboratory of Rudge-Whitworth Manufacturers of steel balls, ball bearings, pedal and motorcycles and detachable wire wheels.

LATHE WORK

Time Allowances. Suggestions for Turning Operations (Drehakkorder), F. Lohage. Werkstattstechnik, vol. 15, no. 12, June 15, 1921, pp. 355–358, 4 figs. Notes in determination of working time for turning operation, turning spindles and bolts, and cutting threads on lathe. Includes table for determination of working time for cutting Whitworth threads.

LATHES

Relieving. The Importance of Relieving Lathes in High-Grade Machine Construction (Die Bedeutung der Hinterdrehbank für den hochwertigen Maschinenbau), C. E. Berck. Der praktische Maschinen-Konstrukteur, vol. 54, no. 22, June 2, 1921, pp. 89–92, 15 figs. Details of lathe constructed by Schüttoff & Bässler, Chemnitz, Germany, for backing off the teeth of milling cutters, hobs, etc.

LIGNITE

Briquetting. Fuel Loss through the Briquetting of Lignite (Der Brennstoffverlust durch die Brikettierung der Braunkohle), H. Berner. Chemiker-Zeitung, vol. 45, no. 42, Apr. 7, 1921, pp. 333–335. It is shown that fuel consumed in briquet factory does not represent fuel loss, and results of calculations show that from original fuel consumption in factory of from 17 to 31 per cent. the actual fuel loss due to savings through heat used for drying, etc., is only about 8 per cent. Report of expert committee of Central German Lignite Syndicate.

German Industry. The Rhenish Lignite Industry. (Grundlinien der rheinischen Braunkohlenindustrie), Rudolf Adrian. Braunkohle, vol. 19, nos. 31, 32, 33, 35 and 36, Nov. 13, 20, 27, Dec. 11, and 18, 1920, pp. 381–384, 394–399, 407–411, 431–434 and 445–447. Points to increasing importance of Rhenish lignite in comparison to anthracite as fuel. Long-distance supply of electric energy from the lignite mines; organization of the Lignite Briquet Sales Assn., its effects on prices, production, etc. Suggestions for future development; transportation problem.

Research. Researches upon Brown Coals and Lignites. Part I—Heat Treatment at Temperatures below 400 Deg. C. as a Possible Method for Enhancing Their Fuel Values, William A. Bone. Proc. Royal Soc., vol. 99, no. A698, June 1, 1921, pp. 236–251. Treatment was found to improve fuel values of brown coals and lignites.

LOCOMOTIVE BOILERS

Heat Transmission in Flues. Heat Transfer in Flues—a Graphic Method of Calculation, A. J. V. Umanski. Engineering, vol. 111, no. 2893, June 10, 1921, pp. 702–703, 2 figs. Graphs for computing temperature drop in flues of various diameters.

LOCOMOTIVES

Baldwin Locomotive Works. Baldwin Builds Forty Locomotives for Southern Pacific. Ry. Rev., vol. 68, no. 26, June 25, 1921, pp. 966–968, 3 figs. Pacific type, 2–10–2 type for heavy freight traffic and switching locomotives.

Canadian Pacific Railway. A Locomotive Designed for Rigorous Operating Conditions, W. H. Winterrowd. Ry. Rev., vol. 68, no. 25, June 18, 1921, pp. 929–936, 14 figs. Pacific type locomotive designed for Canadian Pacific Ry. Characteristics: Cylinder, diameter and stroke, 25 in. by 30 in.; boiler pressure, 200 lb. per sq. in.; diameter drivers, 75 in.; weight engine, total 299,000 lb.; heating surface, total 3529.6 sq. ft.

Consolidation Type. Consolidation Locomotives for the Western Maryland. Ry. Mech. Engr., vol. 95, no. 7, July 1921, pp. 419–422, 8 figs. Characteristics: Cylinders, 27 in. by 32 in; boiler type, straight top; boiler diameter, 88 in.; working pressure, 210 lb. per sq. in.; tractive effort, 68,200 lb.; total weight, 294,900 lb.

The New Consolidation Locomotive of the Belgian State Railway (Les nouvelles locomotives "Consolidation" des chemins de fer de l'etat belge), M. E. Minsart. Bulletin technique de l'Association des Ingénieurs sortis de l'Ecole Polytechnique de Bruxelles, vol. 17, no. 2, 1920–1921, pp. 117–127, 3 figs. Manufactured in America. Characteristics: Cylinders, 610 mm. diameter by 711 mm. stroke; interior diameter of boilers, 1727 mm.; heating surface, total, 172.2 sq. m.; superheating, 51.1 sq. m.; total weight in working order 84500 kg.; tractive effort at 65 per cent of boiler pressure, 15,840 kg.

Cut-off Control. The Automatic Control of Locomotive Cutoff, E. S. Pearce. Ry. Age, vol. 70, no. 25, June 24, 1921, pp. 1451–1456, 11 figs. Tests conducted by Big Four Ry.

Driving Wheels. Methods Used in Locomotive Driving Wheels, Axle and Crankpin Work, Frank A. Stanley. Am. Mach., vol. 54, no. 25, June 23 1921, pp. 1070–1072, 8 figs. Present practice on several classes of work in Southern Pacific shops. Allowance required for shrinking tire on driving wheels.

Feedwater Heating. Developments in Locomotive Feed Water Heating. Ry. Rev., vol. 69, no. 2, July 9, 1921, pp. 44–46, 3 figs. Refinements in design facilities return of condensate to feedwater and elimination of water stops.

Locomotive Feedwater Heating (Die Speisewasservorwärmung im Lokomotivbetriebe), R. Sanzin. Verkehrstechnik, vol. 38, no. 7, Mar 5, 1921, pp. 85–87. Advantages of feedwater heating. Drummond, Caille-Potonié, Worthington and Knorr systems.

Power of Increasing. Vitalizing Locomotives, George M. Basford. Official Proc. New York Railroad Club, vol. 31, no. 7, May 20, 1021, pp. 646, 12 figs. Increasing power of locomotives as means for remedying transportation congestion.

Repairs. Manufacturing Standard Locomotive Repair Parts, M. H. Williams. Ry. Mech. Engr., vol. 95, no. 7, July 1921, pp. 451–455, 7 figs. Method of standardizing and manufacturing locomotive repair parts in central production shops.

Shops. Railway Machine Shop Practice — 1. Machy. (Lond.), vol. 18, no. 455, June 16, 1921, pp. 312–325, 12 figs. Methods employed in locomotive shops of Great Western Ry. Co., England.

Speed Indicators. The Best Relative Variable in Registration of Speed in Railway Operation (Die zweckmässigste Bezugsvariable bei der Geschwindigkeitsregistrierung im Eisenbahnbetrieb), W. Hort. Verkehrstechnik, vol. 38, no. 1, Jan. 5, 1921, pp. 1–3, 4 figs. Diagrams measured with different speed indicators comparing use of time or

distance as relative variable. In Bruhn system distance and speed are recorded directly whereas time acceleration and retardation are computed from diagram.

Superheater. Pyrometers Promote Locomotive Efficiency. Ry. Mech. Engr., vol. 95, No. 7, July 1921, pp 433, 2 figs. Tests showing values of pyrometers applied to superheater locomotives.

Spiral Tubes and Superheaters in Connection with Fuel Economy in Steam Locomotives and Fire-Tube Boilers (Essrohre und Spiralüberhitzer und Brennstoffersparnis bei Dampflokomotiven und Heizröhrenkesseln), K. E. Nordling and R. Bengtzon. Analen für Gewerbeu. Bauwesen, vol. 88, no. 10, May 15, 1921, pp. 83–87, 3 figs. Spirally corrugated tube known as the Ess tube, manufactured by the Uddeholms Aktiebolag, Uddeholm, Sweden.

Valve Gear. Poppet-Valve Gear for Steam Locomotives (Ventilsteuerung für Dampflokomotiven), H. Wittfeld. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 24, June 11, 1921, pp. 623–625, 10 figs. Describes Lentz valve gear which can be installed in existing locomotives in place of piston valves without alteration of cylinder and driving rod. Results of extended experimental operation.

LUBRICATING OILS

Mineral. The Improvement of the Lubricating Properties of Mineral Oils, J. H. Hyde. Engineering, vol. 111, no. 2893, June 10, 1921, pp. 708–709, 10 figs. Improvement of lubricating properties of mineral oils by addition of fatty oils and acids. From experiments conducted at British Nat. Physical Laboratory.

Research. Investigation into Properties of Lubricating Oils. Automotive Industries, vol. 45, no. 1, July 7, 1921, pp. 16–17. Report of tests made by British committee covers measurement of coefficient of friction at various temperatures and with oils of various viscosities. Comparisons of vegetable, animal and mineral oils with and without addition of refined or deflocculated graphite are included.

Tests. Endurance Test of Force Feed Oils, J. G. O'Neill. Jl. Am. Soc. of Naval Engrs., vol. 33, no. 2, May 1921, pp. 248–260, 9 figs. It is concluded that mineral lubricating oils, derived from asphaltic base crude or paraffin base crude and of same viscosity at operating temperatures, will give same service in force-feed lubrication system.

LUBRICATION

Bearings. Oil Consumption and Friction Losses (Oelverbrauch und Reibungsverluste), W. Torau. Verkehrstechnik, vol. 38, no. 6, Feb. 25, 1921, pp. 75–76, 2 figs. Lubricating device said to have been successfully used in transmission-gear construction, machine tools, etc. Device is suitable for railway cars and their drives.

Tests. Measures for Improvement of Lubrication on the Berlin Street Railway (Massnahmen zur Verbesserung des Schmiermittelverbrauchs bei der Berliner Strassenbahn), H. Simmrock. Elektrische Kraftbetriebe u. Bahnen, vol. 19, no. 10, May 24, 1921, pp. 114–115. Results of tests with lubricants and lubricating devices carried out with a view to devising method for reducing consumption of oil.

M

MACHINE SHOPS

Power-Plant. Power Plant Machine Shops, W. O. Rogers. Power, vol. 54, no. 1, July 5, 1921, pp. 12–19, 26 figs. Machine tools found in use in representative power-plant machine shops.

Railways. Railway Machine Shop Practice—II Machy. (Lond.), vol. 18, no. 456, June 23, 1921, pp. 349–351, 6 figs. Methods employed in locomotive shops of Great Western Ry. Co., England.

Railway Machine Shop Practice—IV. Machy. (N. Y.), vol. 27, no. 11, July 1921, pp. 1015–1017, 7 figs. Methods used in machining crown brasses, driving-boxes, and shoes and wedges.

MACHINE TOOLS

Drive. Machine-Tool Driving, J. D. Hope. Mech. World, vol. 69, no. 1798, June 17, 1921, Pp. 459–460. Individual electric driving arrangements versus group system of driving.

MALLEABLE IRON

Casting. American Malleable Cast Iron—XIII, H. A. Schwartz. Iron Trade Rev., vol. 68, no. 26, June 30, 1921, pp. 1792–1797, 5 figs. Electric furnace melting. Kranz triplex process.

MARINE BOILERS

Manufacture. Marine Boiler Construction—II. Machy. (Lond.), vol. 18, no. 454, June 9, 1921, pp. 295–300, 12 figs. Methods and machines employed in representing English shops.

MARINE ENGINES

Oil. Modern Marine Oil Engines—I. Engineer, vol. 131, no. 3416, June 17, 1921, pp. 633–635 and 644, 5 figs. Doxford 3000-i.hp. opposed-piston type.

MEASURING INSTRUMENTS

Internal Measurements. New Light on Internal Measurements, John Bath. Am. Mach., vol. 54, no. 26, June 30, 1921, pp. 1110–1114, 4 figs. Forms of contacts for measuring cylindrical surfaces. Results induced by presence of oil on surfaces in contact.

Pneumercator. The Pneumercator System. Ship building & Shipping Rec., vol. 17, no. 24, June 16, 1921, pp. 745–746, 5 figs. Method of recording height or weight of liquid at distant point.

METAL DRAWING

Seamless Vessels. The Drawing of Seamless Vessels and the Tools Therefor (Das Ziehen von nahtlosen Gefässen und die Werkzeuge hierfür), Alfred Wildner. Der praktische Maschinen-Konstrukteur, vol. 54, no. 22, June 2, 1921, pp. 93–95, 1 fig. General rules are set forth and suitable tools described.

METALS

Calorizing. Treating Metal to Resist Heat, Arthur V. Farr. Iron Trade Rev., vol. 68, no. 25, June 23, 1921, pp. 1724–1727, 13 figs. Calorizing process. Material is placed in rotary retort which contains finely divided aluminum, and there heated in reducing atmosphere. Resultant alloy surface is thus formed that withstands abrasion.

METEOROLOGY

Cloud Systems. Cloud Systems (Sur les systèmes nuageux), Ph. Schereschewsky. Comptes rendus des Séances de l'Académie des Sciences, vol. 172, no. 23, June 6, 1921, pp. 1429–1431. Method of studying cloud systems. International classification.

Weather Forecasting. Weather Forecasting (Le probleme de la prevision du temps), L. Dunoyer and G. Reboul. Journal et Physique et le radium, vol. 2, no. 5, May 1921, pp. 129–131, 1 fig. Experience of Meteorological Service of French army.

METRIC SYSTEM

apan. The Metric System in Japan, J. H. Blakey. Power Plant Eng., vol. 25, no. 13, July 1, 1921, pp. 673. Obligatory adoption of metric system in Japanese empire. Translated from Comptes rendus de l'Académie des Sciences.

MILLING CUTTERS

Screw-Thread. Helical Cutters for Milling Screw Threads (Rillenfräser zur Gewindeherstellung). Der praktische Maschinen-Konstrukteur, vol. 54, no. 12, Mar 24, 1921, pp. 51–56, 8 figs. Shows why such cutters should be made only with straight chip flutes. Reprinted in full from Loewe-Notizen, published by Ludw. Loewe Corp.

MILLING MACHINES

Drum Type. Manufacturing Applications of Ingersoll Drum-Type Milling Machines, J. V. Hunter. Am. Mach., vol. 55, no. 1, July 7, 1921, pp. 23–27, 21 figs. Fixtures for holding work. Automatic clamping devices.

MOLDING METHODS

Green Sand. Costs Dictate Changes in Molding, Pat Dwyer. Foundry, vol. 49, no. 13, July 1, 1921, pp. 501–509, 16 figs. Experience of Muncie Foundry & Machine Company, Muncie, Ind. Dry sand has been abandoned in favor of green-sand method for molding automobile cylinders.

MONEL METAL

Latent Heat of Fusion. The Latent Heats of Fusion of Nickel and Monel Metal, Walter P. White. Chem. and Met. Eng., vol. 25, no. 1, July 6, 1921, pp. 17–21. Experimental determination of latent heats of nickel and monel metal and of their specific heats for intervals to 1360 and 1260 degs. cent., respectively. Latent heat of nickel was 73 calories per gram and that of monel metal 68 calories per gram.

MOTOR BUSES

Operation. Akron's Motor Bus Route. Elec. Ry. Jl., vol. 57, no. 26, June 25, 1921, pp. 1164–1167, 7 figs. Non-competitive route operated in connection with housing development.

Trolley. Electrification at Edinburgh. Elec. Ry. Jl., vol. 58, no. 1, July 2, 1921, pp. 12–14, 3 figs. Gasoline motor buses and electric railway cars replace cable operation. Choice was determined by traffic power and price conditions.

Pioneer Trackless Trolley Installation. Elec. Ry. Jl., vol. 57, no. 26, June 25, 1921, pp. 1158–1161, 7 figs. Experimental trolley buses operated in conjunction with rail service at Richmond, Va.

Trackless Trolley Line in Austria (Elektrische Oberleitungs-Automobillinie Pötzleinsdorf-Salmanns dorf), Ernst Findeis. Elektrotechnik u. Maschinenbau, vol. 39, no. 22, May 29, 1921, pp. 270–271, 1 fig. Interurban bus line in vicinity of Vienna with overhead current supply, according to Austro-Daimler-Stoll system, in use since 13 years, with less cost of installation and operation than in the case of street-railway line and gasoline-burning buses. Address before Int. Street and Narrow-Gage Ry. Congress, Vienna.

MOTOR PLOWS

German. Modern German Motor Plows (Neuere deutsche Motorpflüge), Richard Bussien. Oel- u. Gasmaschine, vol. 18, no. 6, June 1921, pp. 81–96, 21 figs. Details of various types.

MOTOR TRANSPORT

Trains. A Self-Propelled Highway Freight Train of 30-tons Net Load (Der Müllerzug), E. Fränkel. Verkehrstechnik, vol. 38, no. 13, May 5, 1921, pp. 165–170, 5 figs. The separate trucks, which are electrically driven by current generated in leading truck by a steam or internal-combustion engine, run in track of first car, due to a special steering gear. Use of train as feeder for railway lines and for testing traffic in planned routes not yet built. Trains with heavy steam cars in England reached a speed of 10 to 12 km. per hr. on a 70-km. stretch.

MOTOR TRUCKS

Leyland Steam Wagon. The Leyland Steam Wagon, Engr., vol. 131, no. 3415, June 10, 1921, pp. 616–617, 7 figs. Hydraulic tipping steam wagon manufactured by Leyland Motors, Ltd., Leyland, England.

Manufacture. Fits, Tolerances and Heat Treatments Applied in Production, C. T. Bates. Automotive Industries, vol. 44, no. 24, June 16, 1921, pp. 1314–1326, 9 figs. Data covering actual practice employed by many manufacturers in production of all parts used in heavy truck. Same fits, tolerances and heat treatments are applicable in production of parts for passenger cars, light trucks and other automotive vehicles.

MOTORCYCLES

British. Review of Engineering Features of British Motorcycles, M. W. Bourdon. Automotive Industries, vol. 44, no. 25, June 23, 1921, pp. 1376–1381, 6 figs. Types exhibited at Olympia show.

MOTORSHIPS

German-Built. Germany to Build High Powered Diesels. Mar. Eng., vol. 26, no. 7, July 1921, pp. 545–547, 3 figs. Motorship under construction in Germany that is to carry two 3000-b.hp. Sulzer Diesel engines.

N

NICKEL

Plating Solutions. "Black Nickel" Plating Solutions, George B. Hobagoom, T. F. Slattery and L. B. Ham., U. S. Dept. of Commerce, Bur. of Standards, Technologic Papers, no. 190, April 4, 1921, 9 pp. Results of experiments on plating solutions used to produce "government bronze" finish on military hardware.

NON-FERROUS METALS

Ship Construction. Non-Ferrous Metals and Compositions, Horace Holden Thayer. Mar. Eng., vol. 26, no. 7, July 1921, pp. 524–533. Composition of metals used in ship construction. Table of brasses, bronzes and bearing metals for ship specifications.

O

OIL FIELDS

Argentina. Geological Study of Comodoro Rivadavia Oil Fields Being Exploited by Argentina Government (Estudio geológico de la zona de reserva de ea explotación nacional de petróleo en Comodoro Rivadavia), Ricardo Wichmann. Ministerio de Agricultura de la Nación, bul. no. 25, 1921, 19 pp., 3 figs.

India. Petroleum in the Punjab and North-West Frontier Province, E. H. Pascoe. Memoirs of Geological Surveyof India, vol. 40, part 3, 1920, 493 pp., 20 figs. Geological and physical features of oil fields.

Mexican. The Production and Combustion of Mexican Fuel Oil—II, J. M. Pettingell and J. R. Carlson. Combustion, vol. 4, no. 6, June 1921, pp. 18–23, 9 figs. Notes on drilling wells and transporting oil.

Peru. Peruvian Oil Fields, Vernon F. Marsters. Eng. & Min. Jl., vol. 111, no. 26, June 25, 1921, pp. 1073–1075, 1 fig. Geological description of fields and statistics of production.

Spain. Petroleum in Spain (Petroleos en España), Pablo Fábrega. Revista minera metalurgica y de Ingenieria, vol. 72, no. 2782, May 1, 1921, pp. 245–247. Account of explorations.

OIL FUEL

Coal vs. Relative Efficiencies with Coal and Fuel Oil, A. W. Darter. Power Plant Eng., vol. 25, no. 13, July 1, 1921, p. 657. Comparative boiler tests with Texas lignite and with Mexican fuel oil.

OIL SHALES

Distillation. A Study of the Saturated and Unsaturated Compounds of Shale Oils, C. W. Botkin. Petroleum Times, vol. 5, no. 126, June 4, 1921, pp. 659–663. Determination of saturates and unsaturates. Distillations of crude asphaltic shale oil. Effect of distillation of oil on saturates and unsaturates and their distillation.

The Distillation of Oil Shale, A. H. Low. Petroleum Times, vol. 5, no. 127, June 11, 1921, pp. 689–690, 1 fig. Method adopted in Colorado School of Mines.

Testing. Anglo-Persian Activity in New Brunswick Oil Shales, Alexander Gray. Can. Min. Jl., vol. 42, no. 24, June 17, 1921, pp. 474–479. Eight ton testing plant in operation, Technical staffs to be increased and larger plans to be framed when results satisfactory.

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PARACHUTES

Types. New Types of Parachutes, Alfred Gradenwitz. Aviation, vol. 11, no. 1, July 4, 1921, pp. 22, 3 figs. Designs developed by German army.

PETROLEUM INDUSTRY

By-Products. The Development of an Oil By-Product Industry, Eric K. Rideal. Chem. Age. (Lond.), vol. 4, no. 104, June 11, 1921, pp. 666–668. Possibility of establishing by-product industry in connection with oil in much the same way as is done with coal.

PIPE LINES

Hot-Oil Transportation. Pipe-Line Transportation of Hot Oil, Leonard L. Barrett. Chem. & Metallurgical Eng., vol. 24, no. 26, June 29, 1921, pp. 1148–1152, 3 figs. Study of thermal losses in hot petroleum transit lines. Calculations based on d'Arcy's hydraulic formula for spacing pumping and heating stations. Curves of hydraulic gradient for insulated and uninsulated 8-in. lines.

PIPE, STEEL

Centrifugally Cast. Mold Serves as Electric Furnace, E. C. Kreutzberg. Iron Trade Rev., vol. 69, no. 1, July 7, 1921, pp. 33–35, 6 figs. Cammen patented process. Metal is melted electrically in the same mold in which it is cast. Process will be used at plant of Metal Alloys Co., Elizabeth, N. J., for manufacturing aluminum-bronze tubes of all diameters.

PISTONS

Aluminum. Problems and Possibilities of the Aluminum Piston, Walter Rosenhain. Automotive Industries, vol. 44, no. 24, June 16, 1921, pp. 1264–1266 and 1301. Advantages of and limitations of aluminum piston for automobile and aeroplane engines.

Crank-Driven. Results Obtained with Crank-Driven Planers, Edward K. Hammond. Machy. (N. Y.), vol. 27, no. 11, July 1921, pp. 1052–1056, 9 figs. Methods of operating machines possessing features of both planer and shaper.

PLANING

Production System. Production Planing in Machine Tool Plants. Machy. (Lond.), vol. 18, no. 455, June 16, 1921, pp. 326–330, 6 figs. Importance of using adequate number of stops in setting up planer work. Tables of planing speeds and feeds for roughing cuts in various materials.

POLES, WOODEN

Specifications. British Standard Specification for Red Fir Wood Poles for Telegraph and Telephone Lines, British Eng. Standards Assn., no. 139, Feb. 1921, 8 pp. Methods of creosoting.

PLATES

Deflection. The Deflection of a Rectangular Plate under Single Loads (Ueber die Biegung der rechteckigen Platte durch Einzellasten), A. Nádai. Bauingenieur, vol. 2, no. 11, June 15, 1921, pp. 299–304, 6 figs. Determination of deflection and distribution of stress in a fixed-in plate strip with concentrated load. Application to different cases of stress in rectangular plates.

Stresses. Strength of Flat Elliptical Plate Loaded Uniformly and Supported at the Perimeter, Tzuruzo Matsumura. Jl. Soc. Mech. Engrs., Tokyo, Japan, vol. 24, no. 68, May 1921, pp. 31–40, 1 fig. Calculations.

PULVERIZED COAL

Application to Boilers. Pulverized-Coal Furnaces for Steam Boilers (Die Kohlenstaubfeuerung für Dampfkessel), F. Schulte. Glückauf, vol. 57, no. 18, Apr. 30, 1921, pp. 413–419, 4 figs. Describes plants for drying and crushing of coal and for conveying of pulverized coal to furnace burners. Favorable and unfavorable conditions for burning pulverized coal.

Boiler Firing. Boiler Tests with Pulverized Illinois Coal, Henry Kreisinger and John Blizard. Coal Industry, vol. 4, no. 6, June 1921, pp. 291–293, 2 figs. Results of series of 11 tests made on 468-hp. Edgemoor boiler equipped with Foster superheater and fired with pulverized coal. Tests were made by Fuel Section of U. S. Bur. of Mines in coöperation with Research Dept. of Combustion Eng. Corp. Results indicated that it is not necessary to pulverize to fineness of 85 per cent through 200 mesh screen in order to obtain efficiency.

Operation with Pulverized Coal, A. J. Dixon. Power, vol. 54, no. 1, July 5, 1921, pp. 24–25, 1 fig. Test to determine commercial efficiency of pulverized coal as boiler fuel being conducted at power plant of Rialto Bldg., St. Louis, Mo.

Oil Fuel on Hull Tramways: Comparison with Coal Consumption, E. S. Rayner. Tramway & Ry. World, vol. 49, no. 830, June 16, 1921, pp. 289–293. Comparative cost and results of operating boilers in power house 14 days under oil fuel and 14 days under coal.

Pulverized Firing in Steam Generation, F. J. Crolius. Assn. Iron & Steel Elec. Engrs., vol. 3, no. 6, June 1921, pp. 161–168 and ((discussion) pp. 188–198. Survey of developments. Classification of methods into indirect firing and direct firing. Design of combustion chambers. Economies of using pulverized coal.

Stoker Firing vs. Pulverized Coal versus Stoker Firing, F. P. Coffin. Power, vol. 54, no. 2, July 12, 1921, pp. 52–54, 2 figs. From forthcoming book on "The Utilization of Coal on a Multiple-Products Basis."

Uses. Heating with Pulverized Coal (Le chauffage au charbon pulvérisé), P. Frion. Chaleur et Industrie, vol. 2, no. 13, May 1921, pp. 278–284. Survey of developments on Europe and America. (To be continued.) Report prepared under auspices of French Interministerial Committee appointed to study best utilization of fuels.

Industrial Heating with Pulverized Coal (Le chauffage industriel au charbon pulvérisé), Paul Frion. Revue générale de l'Électricité, vol. 9, nos. 23 and 24, June 4 and 11, 1921, pp. 817–824 and 856–862. Typical installations. Advantages of pulverized coal and possibilities of its application in various industries. (Concluded.) Report of French Interministerial Committee appointed to study best utilization of fuels.

Use of Pulverized Coal for Heating Furnaces and Boilers (L'emploi du charbon pulvérisé pour le chauffage des fours et des chaudiéres). Génie Civil, vol. 78, no. 22, May 28, 1921, pp. 459–462. Developments in Europe and America. Report of Committee on Economical Combustion of Fuel, appointed by French Government. From Journal Officiel.

PUMPING ENGINES

Corliss. Triple Corliss Pumping Engine for Margate Waterworks. Engr., vol. 131, no. 3414, June 3, 1921, pp. 588–590, 5 figs. Hathorn, Davey & Co. standard vertical triple Corliss pumping engine forcing water to surface from depth of 130 ft. and forcing it a distance of nearly 15 miles against head of 300 ft.

PUMPS

Rotary Exeter. Suction Pump Operates upon New Principle. Iron Trade Rev., vol. 68, no. 25, June 23, 1921, pp. 1723, 2 figs. Description of Exeter rotary pump manufactured by Exeter Machine, West Pittston, Pa.

Turbine-Driven. Jennings Turbine-Driven Return-Line Heating Pump. Power, vol. 54, no. 1, July 5, 1921, p. 6, 3 figs. Designed for use in connection with heating or drying systems.

PUMPS, CENTRIFUGAL

Design. Increased Output with Centrifugal Pumps and Blowers (Gesteigerte Leistung bei Schleuderpumpen und -gebläsen), Edmund Pocher. Fördertechnik u. Frachtverkehr, vol. 14, no. 11, May 27, 1921, p. 119–121, 7 figs. Discusses inflow and outflow in suction and pressure pipes of pumps and blowers, and use of suction funnels and conical pressure pipes and diffusors, advantages of which are demonstrated. Deals also with inflow and especially outflow from impeller and emphasizes importance of experimental results for internal design of pumps and blowers.

Efficiency. New Method of Determining Efficiency of Centrifugal Pumps, Allen F. Sherzer. Eng. News-Rec., vol. 86, no. 26, June 30, 1921, pp. 1114–1115, 3 figs. Efficiency contours for centrifugal pumps in terms of gallons per minute and specific speeds. Graphs showing relation between capacity and efficiency and relation between specific speeds and efficiency for horizontal centrifugal pumps.

Water Leakage. On the Leakage of Water through the Clearance Rings in a Centrifugal Pump, Otogoro Miyagi, Jl. Soc. Mech. Engrs., Tokyo, Japan, vol. 24, no. 68, May 1921, pp. 15–29, 3 figs. Technical study.

R

RAILS

Alloy-Steel. On the Question of Special Steels, W. C. Cushing. Bul. Int. Ry. Assn., vol. 3, no. 6, June 1921, pp. 577–640. Comparative study of suitability of various steel alloys for rail manufacture, from records of experience of railways in different parts of the world.

Hardening "In Situ." The Sandberg "In Situ" Rail Hardening Process, A. E. Shirter. Acetylene Jl., vol. 23, no. 1, July 1921, pp. 15–17, 2 figs. Hand propelled truck fitted with equipment for heat-treating rails by blowpipes. Experience of British Electric Railway.

Wooden. The Widegren Wooden Rail System (Transportbane-System Widegren), K. A. Widegren. Teknisk Tidskrift (Veckoupplagean), vol. 51, no. 14, Apr. 9, 1921, pp. 161–164, 7 figs. Track consists of roughly hewn beams, resting on a trestle or ties. Wheels have rubber tires without flanges. Railway has proved to be very safe; trucks run smoothly, wear and tear is not great, and cost of installation is about 35 to 50 per cent that of steel railways.

RAILWAY ELECTRIFICATION

Brazil. Electrification of the Paulista Railway, Brazil, S. A. W. D. Bearce. Gen. Elec. Rev., vol. 24, no. 7, July 1921, pp. 620–627, 7 figs. Motor power equipment consists of eight freight locomotives weighing 100 tons each and four passenger locomotives weighing 120 tons each.

Substituting Water Power for Wood Fuel in Brazil, W. D. Bearce. Ry. Rev., vol. 69, No. 1, July 2, 1921, pp. 1–5, 5 figs. Electrification of Paulista railway with American equipment.

3,000-Volt Electrification on Paulista, S. B. Cooper and W. D. Bearce. Elec. Ry. Jl., vol. 57, no. 24, June 11, 1921, pp. 1075–1084, 24 figs. Railway electrification of 28-mile section of double-track main-line of Brazilian railway. Details of Westinghouse and Gen. Elec. locomotives used.

Europe. Railway Electrification in Europe, J. V. Dobson and F. E. Wynne. Elec. Ry. Jl., vol. 57, no. 24, June 11, 1921, pp. 1068–1074, 12 figs. Impressions of present practices and tendencies gathered by writers on trip through England, Norway, Sweden, Germany, Switzerland, Italy and France. Summary of points of difference between American and European railway usage.

High-Tension Direct-Current. Note on the Electrification of French Railways (Note sur l'électrification des réseaux de chemins de fer français), M. A. Ferran. Revue generale des Chemins de Fer et des Tramways, vol. 40, no. 5, May 1921, pp. 313–352, 18 figs. Study of electric traction by high-tension direct surrent.

High-Voltage. Railroad Electrification at High Voltage, F. H. Shepard. Ry. Age, vol. 70, no. 25, June 24, 1921, pp. 1441–1444, 6 figs. Development of alternating-current equipment and its relation to power supply.

RAILWAY MAINTENANCE

Organization. On the Question of Maintenance and Supervision of the Track, Chas. J. Brown. Bul. Int. Ry. Assn., vol. 3, No. 6, June 1921, pp. 663–690, 21 figs. Report from railways on their system of organization of staff and their methods of carrying out the work of maintenance of track.

RAILROAD MANAGEMENT

Economies. Possible Economies in Railroad Management, W. Jett Lauck. Indus. Management, vol. 62, no. 1, July 1, 1921, pp. 7–9. Argument on behalf of railroad employees before U. S. R. R. Labor Board.

Legislation, Switzerland. Federal Law Regulating Organization and Management of Federal Railways (Loi fédérale réglant l'organisation et l'administration des chemis de fer fédéraux). Bulletin technique de la Suisse romande, vol. 47, no. 12, June 11, 1921, pp. 136–140. Project of law evolved by Swiss Dept. of Railways and submitted to Federal Chambers in June 1921.

RAILWAY MOTOR CARS

Internal-Combustion-Engines. Railway Motor Coach with Internal Combustion Engine. Engr., vol. 131, no. 3415, June 10, 1921, pp. 612–613, 6 figs. Direct drive by internal-combustion engine. Translated from Génie Civil.

RAILWAY OPERATION

Car Service. The Delaware and Hudson's New Car Service Rules. Ry. Age, vol. 71, no. 2, July 9, 1921, pp. 73–75, 3 figs. Revised rules for promoting prompt car movement simplified for the benefit of yardmasters.

Cost Accounting. Remedies for Wastes in Railway Operation, F. J. Lisman. Ry. Age, vol. 71, no. 2, July 8, 1921, pp. 59–63. Suggestions in regard to cost-keeping methods.

Train Control. The Train Control System for the North British Railway. Ry. Gaz., vol. 34, no. 22, June 3, 1921, pp. 835–846, 20 figs. Total mileage of railway is 1399.

Train Dispatching. On the Question of Slow-Freight Traffic, Mr. Guerber. Bul. Int. Ry. Assn., vol. 3, no. 6, June 1921, pp. 641–662, 4 figs. Report on organization of train service.

RAILWAY SIGNALING

Repetition of Signals on Locomotive. Automatic Stopping of Trains and Repetition of Signals on Locomotives (Arrêt automatique des trains et répétition des signaux sur les locomotives), C. Vandevelde. Annales de l'Association des Ingénieurs sortis des Ecoles speciales de Gand, vol. 11, no. 5, 1921, pp. 45–62. Advantages and disadvantages of automatic brakes. Necessity of developing simple system for reproducing track signals on locomotives.

Interlocking. New Traffic Locking on C. & O. Relieves Congestion, H. E. Johnson. Ry. Age, vol. 71, no. 1, July 2, 1921, pp. 25–26, 3 figs. Interlocking by alternating current of 125 cycles.

RAILWAY TRACK

Standardization of Material. Standardization of Track Material by French Railways (La standardisation du matériel des voies des chemins de fer français). Génie Civil, vol. 78, no. 22, May 28, 1921, pp. 458–459, 7 figs. Profiles and dimensions of three standard rails and corresponding fishplates proposed by engineering committee appointed by Ministry of War.

RAILWAYS

Rolling-Stock Material Specifications. British Standard Specifications for Railway Rolling Stock Material. British Eng. Standards Assn., no. 24, Mar. 1921. Part 1, 27 pp., 7 figs.: Locomotive, carriage and wagon axles. Part 2, 16 pp., 8 figs.: Locomotive, carriage and wagon tires. Part 3, 24 pp., 7 figs.: Laminated, volute and helical springs, and steel for laminated springs. Part 4, 19 pp., 7 figs.: Steel forgings, blooms and castings. Part 6, 28 pp., 17 figs.: Steel plates, angles, etc., and rivets for locomotives, carriages and wagons.

REDUCTION GEARS

Performance. Reduction Gears for Ship Propulsion, Robert Warriner. Mar. Eng., vol. 26, no. 7, July 1921, pp. 532–538, 5 figs. Performance of single and double reduction gears. Comparison with other methods of propulsion. (Abstract.) Paper read before Soc. of Naval Architects and Mar. Engrs.

REFRIGERATING PLANTS

Internal-Combustion Engines for. Internal-Combustion Engines as Prime Movers for Refrigeration Plants, W. H. Motz. Power, vol. 54, no. 2, July 12, 1921, pp. 58–60, 6 figs. Economy of producer-gas-engine plant.

RESEARCH

Foundry. Research in the Foundry, Engineering, vol. 111, no. 2894, June 17, 1921, pp. 749–750. Work recently undertaken by British Government.

Industrial. Research in Industry, L. A. Hawkins. Jl. Soc. of Automotive Engrs., vol 9, no. 1, July 1921, pp. 20–22. Practice of Gen. Elec. Co.

ROLLING MILLS

Sheet Mills. Milwaukee Sheet Mill Has New Features, Gilbert L. Lacher. Iron Age, vol. 107, no. 25, June 23, 1921, pp. 1681–1685, 8 figs. Bar storage and shipping department are under roof.

Western Sheet Mill New Rolling. George H. Manlove. Iron Trade Rev., vol. 68, no. 25, June 23, 1921, pp. 1715–1719, 9 figs. Installation of Milwaukee Rolling Mill Co. built in two units. Balanced roughing rolls are provided. Bar shear equipped with mechanical piler.

ROPE DRIVE

Bollen Cable Pulley. The Bollen Cable Pulley. Engineering, vol. 111, no. 2895, June 24, 1921, p. 771, 6 figs. System built up of two independent wheels and a movable race. When pulley is in operation, pull on cable causes movable race to be forced inward on side at which pressure comes and as a result rims of two wheels close together and grip cable.

RUDDERS

Kitchen Type. The Kitchen Reversible Propeller (Le gouvernail a changement de marche kitchen). Génie Civil, vol. 78, no. 19, May 7, 1921, pp. 396–397, 6 figs. Rudder is surrounded by system of two cylindrical deflectors mounted on common pivots and capable of rotating jointly or separately about rudder.

S

SCIENTIFIC MANAGEMENT

See INDUSTRIAL MANAGEMENT.

SCREW MACHINES

Tools. The Calculation of Circular Form Tool Diameters Having Top Rake, A. Washington. Machy. (Lond.), vol. 18, no. 455, June 16, 1921, pp. 337–338, 3 figs. Formulas.

SCREW THREADS

Cutting. The Problem of Accurate Thread Cutting, B. M. W. Hanson. Machy. (N. Y.), vol 27, no. 11, July 1921, pp. 1012–1014, 4 figs. Requirements to fulfill in fitting threaded parts. Work of engineering committees in establishing tolerances within so-called commercial limitations.

SCREWS

Specifications. Report on British Standard Heads for British Association Screws. British Eng. Standards Assn., no. 57, Dec. 1920, 7 pp., 9 figs. Schedule of dimensions of various types of heads for small screws for sizes 0 to 15 B. A. covering range of diameters from 6 mm. to 0.9 mm. (0.236 in. to 0.035 in.).

SEARCHLIGHTS

Advertisement Projector. A New Type of Advertising Searchlight ("Atrax"), H. Geitel. Elektrotechnischer Anzeiger, vol. 38, no. 79, May 19, 1921, pp. 509–516. Details of advertisement projector constructed by the Atrax Co., Berlin, said to have a novel and attractive light effect and to be economical in consumption of power.

Naval Targets. Tactical Organization and Employment of Searchlights against Naval Targets, John S. Pratt. Jl. U. S. Artillery, vol. 54, no. 6, June 1921, pp. 525–567, 24 figs.

SHAFTS

Design. Graphical Determination of Shaft Diameters, N. Barnes Hunt. Machy. (N. Y.), vol. 27, no. 11, July 1921, pp. 1036–1037, 2 figs. Charts for graphically finding proper diameters of shafts subjected to combined tension and torsion. Sizes from 15/16 in. to 5 7/16 in. inclusive.

SHIP PROPULSION

Internal-Combustion Engines. Internal Combustion Engines Applied to Propulsion, John F. Metten and J. C. Shaw. Mar. Eng., vol 26, no. 7, July 1921, pp. 542–545. Comparative earning capacities of motorships and oil-burning steamers. Machinery equipment of motorship William Penn.

Methods. Ship Propulsion, T. C. Phillips. Jl. Eng. Inst. of Canada, vol. 4, no. 7, July 1921, pp. 396–404. Modern methods of ship propulsion, reciprocating engine, steam turbine, internal-combustion engine and electric drive.

SHIP PROPULSION, ELECTRIC

Merchant Marine. Electric Propulsion for Merchant Marine, Wilfred Sykes. Jl. Western Soc. Engrs., vol. 26, no. 6, June 1921, pp. 211–219. Comparative fuel requirements of reciprocating engines, gear turbines, electric drive, direct-connected Diesel engines and Diesel-electric drive.

SHIPS

Refrigerator. Balsa Insulation for Refrigerator Ships. Mar. Eng., vol. 26, no. 7, July 1921, pp. 557–560, 3 figs. Standard insulation plans.

SOLDERS

Soft. War Experience with Soft Solders, Hans Schulz. Metal Industry (Lond.), vol. 18, no 23, June 19, 1921, pp. 443–444. Experiments conducted during war by German Naval Dept. on tin-lead, cadmium, Matulot, Thyssen and magnesium solders.

STACKS

Concrete-Encased. Conservation of Corrosion Weakened Steel Stacks by Encasing with Concrete, John V. Schaefer. Eng. & Contracting, vol. 55, no. 25, June 22, 1921, pp. 619–620, 3 figs. Experience South Works of Ill. Steel Co.

STEAM

Flow in Pipes. Handy Steam Velocity and Steam Flow Tables, V. F. Davis. Mar. Eng., vol. 26, no. 7, July 1921, pp. 522. Capacities of steam pipes in pounds per minute with steam-flow velocity of 6000 ft. per min.

Properties. The Specific Volume of Dry Steam, M. J. Eichhorn. Power, vol. 53, no. 25, June 21, 1921, pp. 1006–1007, 1 fig. Nomogram for specific volume dry steam.

STEAM-ELECTRIC PLANTS

Glasgow, Scotland. The Dalmarnock Power Station. Engineering, vol. 111, nos. 2894 and 2895, June 17 and 24, 1921, pp. 736–738, and 748, 12 figs.; and 767–771, 6 figs. June 17: Turbo-alternator, 15,000 kw. capacity. June 24: Electrical equipment.

STEAM ENGINES

25,000-Hp. Three-Cylinder, 25,000-Hp. Steam Engines for Rolling Mill Drive (Machine à vapeur à trois cylinders de 25,000 chevaux pour la commande d'un train de laminoir). Génie Civil, vol. 78, no. 23, June 4, 1921, pp. 469–472, 6 figs. Installation in Middlebrough Steel Works, England.

Uniflow. New Unaflow Engine Design. Power, vol. 53, no. 26, June 28, 1921, pp. 1042–1043, 4 figs. Equipped with high-lift poppet valves of small diameter, which are operated from valve shaft, geared to run at twice speed of main engine shaft.

STEAM ROLLERS

Manufacture. Modern Methods on Steam Roller Construction. Eng. Producton, vol. 11, no. 37, June 16, 1921, pp. 725–729, 13 figs. Interchangeable manufacturing processes at representative works.

STEAM TURBINES

British Thomson-Houston. Recent Improvements in Steam Turbine Design—IV. Engr., vol. 131, no. 3414, June 3, 1921, pp. 592–593 and 596, 8 figs. Recent types manufactured by British Thomson-Houston Co.

Lubrication. Lubrication of Steam Turbines—I. Gen. Elec. Rev., vol. 24, no. 7, July 1921, pp. 651–655. Principles of oil lubrication with special reference to turbine bearings, consideration being given to effects of speed, clearance, cooling by means of oil circulation, viscosity and emulsification.

Parsons. Recent Improvements in Steam Turbine Design—V. C. A. Parsons and Co. Engineer, vol. 131, no. 3416, June 17, 1921, pp. 640–642, 5 figs. Typical installations of Parsons turbines.

[See also BALANCING.]

STEEL

Alloy. See ALLOY STEELS.

Cobalt. See COBALT STEEL.

Fatigue. The Fatigue of Steel. Iron Age, vol. 107, no. 25, June 23, 1921, pp. 1687. Progress made in research and in explanation of causes. Paper read before Am. Inst. Min. & Metallurgical Engrs.

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Stainless. The Uses of Stainless Steel. Engr., vol. 131, no. 3414, June 3, 1921, pp. 598–599. Uses in aeroplane engines, surgical instruments, turbine blades, optical work, drawing instruments, pumps, etc.

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Flaws in Straightening. Flaws Resulting in Steel Pieces during Straightening (Les criques de rectification), Léon Guillet, Jean Galibourg and Pierre Beuret. Revue de Métallurgie, vol. 18, no. 4, April 1921, pp. 213–220, 13 figs. Flaws attributed to heating metal under rollers.

High-Speed Steel. Heat-Treatment of High-Speed Steel Cutting Tools of Intricate Design, A. J. Langhammer. Chem. and Met. Eng., vol. 25, no. 1, July 6, 1921, pp. 30, 3 figs. Comparison of various methods.

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France. The French Iron and Steel Industry. U. S. Dept. of Commerce, Commerce Reports, no. 145, June. 23, 1921, pp. 1709–1715. Statistics of production. Condition of plants and number of workmen.

Prices. The Cause of Industrial Depressions, George Huntington Hull. Indus. Management, vol. 61, no. 11, June 1, 1921, pp. 386–391, 5 figs. Why iron is barometer of trade, and why heavy cut in steel prices is now inevitable.

STEEL MANUFACTURE

Basic Steel. The Behavior of Sulphur in the Thomas Converter (Das Verhalten des Schwefels in der Thomasbirne), E. Herzog. Stahl u. Eisen, vol. 41, no. 23, June 9, 1921, pp. 781–788 and (discussion) pp. 788–789, 2 figs. States that the cooling of pig-iron bath brought about by the addition of lime causes a strong segregation of sulphur in form of sulphide of manganese; in further process of decarbonizing period the sulphur returns to bath in form of sulphide of iron.

Electric Furnaces. Accounting for Electric Alloy and Tool Steel, G. Harvey Porter. Jl. of Accountancy, vol. 32, no. 1, July 1921, pp. 1–15. Tabulation of control accounts, and method of drawing up details of 14 records.

Processes. Development of Iron Ore into Iron and Steel, S. C. Dickerhoff, Jr. Forging & Heat Treating, vol. 7, no. 6, June 1921, pp. 336–337. Chart indicating prices.

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England. British Iron and Steel Centers—IV, Joseph Horton. Iron Trade Rev., vol. 68, no. 25, June 23, 1921, pp. 1720–1722, 1 fig. District of South Wales and Monmouthshire.

France. Steel Works at Hagondange, near Metz (Les aciéries Thyssen a Hagondange, près Metz). Génie Civil, vol. 78, no. 19, May 7, 1921, pp. 393–396, 9 figs. partly on supp. plate.

Power Generation. Power Generation in Steel Mills and Its Relation to Frequency, D. M. Petty. Assn. Iron & Steel Elec. Engrs., vol. 3, no. 6, June 1921, pp. 199–212, 2 figs. Blast-furnace-gas power station. Selection of frequency.

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Mechanical. Limitations of Mechanical Stokers. Power Plant Eng., vol. 25, no. 13, July 1, 1921, pp. 674–675. Limitations of mechanical stokers utilizing Mid-West coals.

STRUCTURAL STEEL

Compression Members. Tests with Compression Members (Versuche mit Druckstäben), H. Gruning. Bauingenieur, vol. 2, no. 11, June 15, 1921, pp. 285–290, 5 figs. Account of two tests carried out by the Steel Construction Testing Committee, showing effect of use of different grades of iron (with varying elasticity) in bar, and also influence of system of articulation.

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German U-Boats. The Construction of U-Boats in the Germania Shipyard (der Bau von Unterseebooten auf der Germaniawerft), H. Techel. Zeit. des Vereines deutscher Ingenieure, vol. 64, no. 52, Dec. 25, 1920, pp. 1097–1103, 26 figs., 8 on supp. plate. Notes on the first U-boats built in the Germania shipyards; the Forelle, built in 1902 for Russia, three other Russian submarines, the Karp, Karras and Kambala, put in service in 1907, and the first German U-boat, built in 1904. The first U-boats built for the German navy with Diesel engines and the development of this type during the war. (Concluded.)

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Automatic. Automatic Substations Entering Electric Service Field, R. J. Wensley. Elec. World, vol. 78, no. 1, July 2, 1921, pp. 14–15, 4 figs. It is said automatic substation has definitely proved success in industries. Advantages claimed are saving in feeder copper and good service rendered.

Brief Review of Automatic Substation Experience on the Aurora Elgin & Chicago R.R., S. E. Johnson. Gen. Elec. Rev., vol. 24, no. 7, July 1921, pp. 610–612, 1 fig. Inspection periods are seven days apart and control equipment is adjusted to furnish maximum of power throughout 24 hours.

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Steamships. Superheated Steam on Steamships, C. H. Peabody. Mar. Eng., vol. 26, no. 7, July 1921, pp. 539–541, 4 figs. Comparison with locomotive and shore practice. Results with reciprocating engines and Scotch boilers.

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Cold. Cold Swaging—II. Machy. (N. Y.), vol. 27, no. 11, July 1921, pp. 1018–1021, 8 figs. Methods employed by Torrington Co., Torrington, Conn., in making swaging dies.

T

TANKS MILITARY

Caterpillar. Caterpillar Vehicles. Automobile Engr., vol. 11, no. 151, June 1921, pp. 198–200, 5 figs. Recent developments of flexible track scheme.

TAR OIL

Creosote Content. The Determination of the Acid Components in Tar Oils, Especially in Low-Temperature-Tar Oils (Ueber die Bestimmung der sauren Bestandteile in Teerolen, insbesondere in Urteerolen), A. Lazar. Chemiker-Zeitung, vol. 45, no. 25, Feb. 26, 1921, pp. 197–199. Improved gravimetric and differential methods for more accurate determination of creosote content in tar oils.

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Multiplex. Multiplex Telegraphy and Telephony on High-Frequency Lines (Multipletelegraphie und -telephonie auf Leitungen mit Hochfrequenz), Karl Willy Wagner. Ingenieur, vol. 36, no. 24, June 11, 1921, pp. 453–464, 34 figs. Account of tests begun in Telegraph Testing Station of Berlin. Experiences with multiplex high-frequency telephone lines between Berlin and Hanover, Berlin and Frankfort, etc. In writer's opinion, high-frequency telegraphy is a much simpler technical problem than ordinary telegraphy. Details of apparatus for operation of the new high-frequency lines.

TERMINALS LOCOMOTIVE

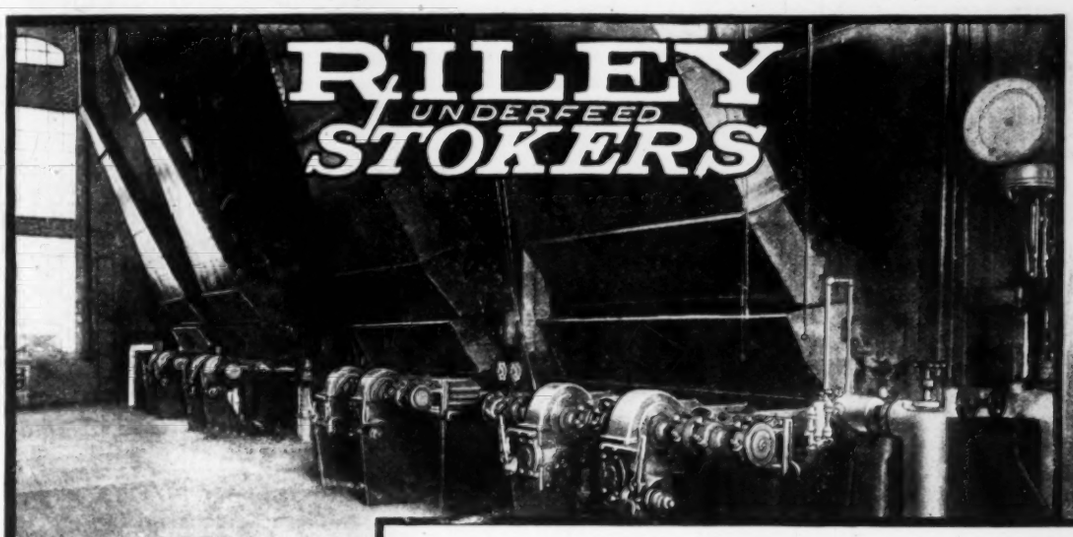
M. K. & T. Ry. New Locomotive Terminal for the M. K. & T. Ry., at Oklahoma City. Ry. Rev., vol. 68, no. 26, June 25, 1921, pp. 959–966, 16 figs. Terminal includes 10-stall roundhouse, machine shop, power plant, water treating plant, reinforced-concrete coaling station, storehouse and track scale built in reclaimed land together with new cut-off line which will obviate necessity for track elevation.

TERMINALS, RAILWAY

Chicago. New Freight Terminal Nearing Completion in Chicago. Ry. Age, vol. 71, no. 2, July 8, 1921, pp. 65–69, 7 figs. Multiple-story construction and elevators are features of Chicago & Alton project.

TIDAL POWER

Utilization. Economics of Tidal Power Develop-



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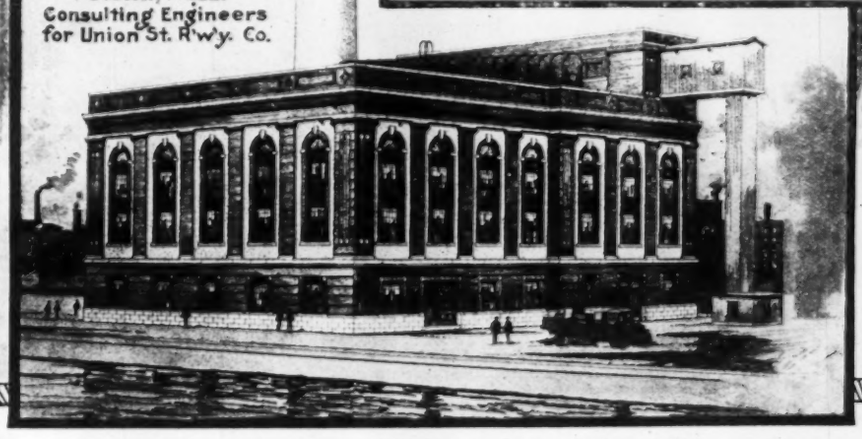

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